Univ. of
Toronto
Library

BINDING LIST MAY 1 1924

Digitized by the Internet Archive
in 2010 with funding from
University of Toronto

http://www.archive.org/details/publicworks53ridg

PUBLIC WORKS

INDEX

VOLUME LIII

JULY TO DECEMBER

1922

L 89524
16.5.24

PUBLIC WORKS JOURNAL CORPORATION
243 WEST 39TH STREET
NEW YORK

PUBLIC WORKS

INDEX

VOLUME 53

JULY—DECEMBER

1922

TD
1
P8
V53

GENERAL INDEX

Accuracy of Old Meters..... 61
Acid Mine Drainage; Germicidal Effect of.....264
Treatment of Wool-Scouring Waste Water..... 90
Activated Sludge for Packing House Waste at Mason City.....262
Sludge in England.....151
Sludge, Study of.....219
Air, Pipe Laying by Compressed...193
Albuquerque, Sludge Digestion in..122
Alkali Soils, Cement Pipe in.....244
Annual Costs of Florida Highways..161
Apparatus, Street Lighting Construction and.....242
A. S. M. I. Convention.....224
Asphalt Macadam in Kansas City.. 16
Augusta, Metering in.....174
Automobiles Break Hydrants..... 73
Bacteria, Denitrification by..... 12
Ballast and Road Metal Manufacturing. 48
Baltimore Balancing Reservoir..... 87
Sewage Works, Sludge Digestion at the..... 97
Base, Black, for Chicago Boulevard..233
, Use of, Before It Sets.....257
Bates Road, Further Tests of..... 5
Road Test, Fourth..... 30
Bensel, John A..... 33
Bidder, Lowest and Best.....119
Bidders, Questionnaries for.....257
Bill, 100% Water, Collection.....154
Bills, Water, in Boston.....235
Birmingham, Sludge Digestion at..107
Black Base for Chicago Boulevard..233
Blasting, Skill in Rock..... 31
Blocks, Tests for Granite Paving...200
Boards, Engineers' Plans for State Health..... 6, 27
Boston, Water Bills in..... 235
Boulevard, Black Base for Chicago..233
, Building Rockaway.....169
, Pittsburgh, Restoration of Bigelow..... 26
Brick, Laying Vertical Fibre.....255
Bridge Abutments, Preventing Scour at 229
, Constructing Arch Ribs of Springfield..... 8
Construction Special Features of Arch..... 11
Foundations, Testing.....192
, Pier Construction, Wells St...174
Piers, Delaware River.....211
Piers, South Street, Philadelphia. 84
Bridges, Pennsylvania Highway...233
, Prevention of Fire in Highway. 228
Brooklyn Bridge Dock, Building...266
Brownsville Avenue Reconstruction..144
Buffalo's Filter Plant, Contract for. 65
Building Brooklyn Bridge Dock...266
Rockaway Boulevard.....169
Cableway, Handling Men by.....248
Caisson Work, Reducing Cost and Time of..... 89
Calcium Chloride for Sand-Clay Roads. 121
Cambridge Water Works Notes..... 68
Canal Break, Hail Causes.....260
Cast-Iron Pipes, Cement Joints for..194
Cement Joints for Cast-Iron Pipes..194
Pipe in Alkali Soils.....244
Production and the Coal Shortage. 116
Cemeteries and Ground Water Supplies. 230
Charleston, S. C., Floating Islands in Storage Reservoir.....195
, Metering in.....173
Check Valves Be Used at Service Meters? Should..... 31
Valves, Use of Meters and Table. 34
Chemical Dosage in Filter Plants, Economical Control of.....258
Chester, Eng., Sand Filter at.....235
Chicago Boulevard, Black Base for..233
Chlorination of Sewage in Stratford..133
Cincinnati, Street and Sewer Work in. 117
Cistern Water, Lead in.....204
City, Small, Sanitating a.....148
Streets, State Funds for.....159
Civil Service Examinations.....270
Clams, Typhoid Fever from.....178
Cleaning, Street, Tables of.....272
Cleburne, Metering in.....107
Coal Strike, Public Utilities During. 180
Collection and Disposal, Garbage, in Richmond, Ind.....251
, 100% Water Bill.....154
, Refuse, Tables of.....281
Color of Fire Hydrants.....161
Compressed Air, Pipe Laying by....193
Concord, Electric Pumping at.....238
Concreting Liberty Highway Tunnels. 198
Concrete Plant, Hetch Hetchy Dam.. 58
Sidewalks in Jacksonville.....234
Troy-Pocahontas Highway... 24
, Wear of..... 68
Connections, Municipal Inspection of Sewer.....169
Constructing Arch Ribs of Springfield Bridge..... 8
Construction Council, The American. 7
, Emsworth Lock and Dam.....162
Operation Increasing..... 24
, Special Features of Arch Bridge. 11
, Street Lighting, and Apparatus. 242
Contractor's Equipment, Rental of..191
Control, Mosquito, by Use of Fishes..195
Convention, A. S. M. I.....224
Cooperation for Public Utilities....245
Copper Sulphate in Hartford Water Supply. 240
Core Walls in Earth Dams.....241
Cost of Sewer Joints in Wet Trenches. 261
Costs, Annual, of Florida Highways..161
Council, The American Construction. 7
Courses, Highway, University of Michigan. 234
Cross Section, Illinois Changes Pavement. 235
Culverts, Sand Centering for.....171
Curves, Rainfall Intensity.....176
Dam Construction, Emsworth Lock and. 162
, The Hetch Hetchy..... 21
Dams, Earth, Core Walls in.....241
Dangerous Gas in Sewage Filters..263
Data, Street Cleaning and Refuse Disposal. 270
Tabulated Sewerage.....205
Day Labor on Public Work.....243
Dayton, Garbage Reduction in.....201
Delaware, Controlling Pollution of the. 110
River Bridge Piers.....211
Denitrification by Bacteria..... 12
Difficulties, River Intake.....196
Direct Oxidation, A Year's Operation of. 219
Disposal of Liquid Sludge, Sand...263
, Refuse, in Europe.....154
Dock, Building Brooklyn Bridge...266
Drag, A New Type of Road.....158
Drainage, Germicidal Effect of Acid Mine. 264
Dumping, Precautions in Refuse....154
Earth Dams, Core Walls in.....241
Hydraulicking in Rhode Island. 238
Economic Subway Construction in Rochester. 234
Economical Control of Chemical Dosage in Filter Plants.....258
Economics, Construction..... 67
Economy, Water Meters and.....159
Effect of Acid Mine Drainage, Germicidal 264
Electric Pumping at Concord.....238
Emsworth Lock and Dam Construction 162
Engineering Employment Service..123
Engineer Wanted, Appraisal.....123
Engineering Positions Open, U. S..228
Society's Publication, Rochester. 228
Engineers, Increased Salaries for.. 47
Plans for State Health Boards, 6, 27, 46, 62
' Reciprocity in Registration of.182
' Salaries for Sanitary.....182
Wanted, Sanitary.....123
Wanted Valuation 123
England, Activated Sludge in.....151
Equipment, Pennsylvania Highway. 41
, Rental of Contractors.....191
Erection, Trolley Bridge..... 42
Ended Water Main in River Bed..160
Europe, Refuse Disposal in.....154
Examinations, Civil Service.....270
Excavation, Hetch Hetchy Dam.... 43
Experimental Highway Tests, Illinois. 253
Fair Allowance for Force Account Work. 192
Federal Survey of Sewage Treatment Plants..... 155
Fellowships in Highway Engineering and Transport.....123
Filter Plant, Contract for Buffalo.. 66
Plants, Economical Control of Chemical Dosage in.....258
, Sand, at Chester, England...235
Filters, Dangerous Gas in Sewage..263
Specifications for Pressure Water. 147
Filtration Plant, Enlarging Harrisburg. 77
Fire Hazard of Pumps..... 63
Hydrants, Color of.....161
Fishes, Mosquito Control by Use of..195
Floating Islands in Storage Reservoir. 195
Flood Protection Work, Strenous. 32
Florida Highways, Annual Cost of..161
Highway Work..... 68
Flow Survey, Hydrant..... 61
Force Account Work, Fair Allowance for.....192
Fort Madison, Unusual Sewer Construction in. 222
Foundations, Testing Bridge.....192
Freak Stream in Washington.....176
Fuel Oil in Harbors.....187
Funds, State, for City Streets.....159
Garbage Collection and Disposal in Richmond, Ind.....251
Reduction in Dayton.....201

Gas, Dangerous, in Sewage Filters..263
In Street Manholes.....241
Gasoline Tax for Motor Vehicles...233
Gas Plant Liquors, Removing Taste from 12
Germicidal Effect of Acid Mine Drainage.....264
Government Sprinting Office.....228
Grading Roads, Cost of.....101
Granite Paving Blocks, Tests for..200
Guards, New Type of Highway....232
Hail Causes a Canal Break.....260
Handling Men by Cableway.....243
Harbors, Fuel Oil in.....187
Harrisburg Filtration Plant, Enlarging.....77
Hartford Water Supply, Copper Sulphate in.....240
Hazard of Pumps, Fire.....63
Health Boards, Engineers' Plans for State.....6, 24, 46, 62
Hetch Hetchy Dam Concrete Plant. 58
Hetchy Dam, The.....21
Hetchy Dam Excavation.....43
Highway Bridges, Pennsylvania....233
, Concreting Troy-Pocahontas.. 24
Courses, University of Michigan.....234
Guards, New Type of.....232
Magazines 234
Nearby, Repairing French. 23
Organization, Pennsylvania State.....1
Programs, Weather, Strikes...115
Research Specialist Wanted..123
Tests, Illinois Experimental..253
Tunnels, Concreting Liberty..198
Highways, $24,000,000 for County.. 27
, Florida, Annual Cost of.....161
, Money Available for.....123
, Truck Versus.....115
Horse Maintenance, Cost of.....83
Hydrant Flow Survey.....61
Hydrants, Automobiles Break.....73
, Fire, Color of.....161
Hydraulicking Earth in Rhode Island.....238
Hydraulic Laboratory, National.. 32
Illinois Changes Pavement Cross Section.....235
Experimental Highway Tests..253
Illumination, Street.....177
Incinerator, Refuse, Letting.....157
Incinerators, Some Refuse.....285
Indebtedness, State, for Public Works.....202
Inspection, Municipal, of Sewer Connections.....160
Inspectors, Training Road.....123
Instruction for Water Filter Operators.....270
Intake, River, Difficulties.....196
Investigation, Stream Pollution....172
Islands, Floating, in Storage Reservoir.....195
Jacksonville, Concrete Sidewalks in..234
Johannesburg, Sewage Treatment at.....218
Joints, Cement, for Cast-Iron Pipes..194
in Sewer Pipes, Tight.....113
, Tests on Tight Sewer.....181
, Water-Tight for Sewer Pipes..165
Kansas City, Asphalt Macadam in.. 16
Labor, Day, on Public Work.....243
Laboratory, National Hydraulic... 32
Lawrence, Mass., New Method of Purifying Water.....197
Laws, State Licensing, Engineering Societies Oppose.....150
Laying Pipe by Compressed Air....193
Pipe in New Bedford.....235
Vertical Fibre Brick.....255
Lead in Cistern Water.....207
Lettings, Refuse Icinerator.....157
Liberty Highway Tunnels, Concreting.....198
Licensing Laws, State, Engineering Societies Oppose.....150
Lighting Construction, Street, and Apparatus 242
, Lima's New Street.....150
Lima's New Street Lighting.....150
Liquid Sludge, Sand Disposal of...263
Loads, Settlement of Soils Under.. 5
Lock and Dam Construction, Emsworth.....162
Louisville Sewerage Controversy... 48
Magazines, Highway.....234
Mains, Steel Water, in New Bedford.....165
, Water, and Meters in St. Louis.....152
, Wood Water.....91
Maintaining Wood-Block Paving in Peoria.....232
Maintenance, Meters Require.....30
, Sewer.....220
Main, Water, in River Bed Eroded..160
Manholes for Valves and Meters...180
, Gas, in Street.....241
Mason City, Activated Sludge for Packing House Waste at....262
Measuring Street Cleaning, Linear Units for.....11
Memphis, Tenn., River Intake Difficulties.....196
Men, Handling, by Cableway.....245
Metering in Augusta.....174
Charleston.....173
Meter Maintenance, Cost of.....106
Meters, Accuracy of Old.....61
and Check Valves, Use of; Table.....34
, Manholes for Valves and.....180
Require Maintenance.....30
? Should Check Valves Be Used at Service.....31
, Water, and Economy.....159
, Water Mains and, in St. Louis..152
Mosquito Control by Use of Fishes..195
Motor Vehicles, Gasoline Tax for....233
Municipal Inspection of Sewer Connection.....160
Negley Run Sewer.....39
Nevada, Draglines, War, Dept. Gives..253
New Bedford, Pipe Laying in.....236
, Steel Water Mains in.....165
Method of Purifying Water...197
Orleans, Manholes for Valves and Meters.....180
Type of Highway Guards....232
Type of Road Drag.....158
Niagara Falls Power Tunnel.....238
North Carolina Mountains, Road Work in.....41
Oil, Fuel, in Harbors.....187
Pollution of Waters.....260
Oiling Road, in Wyoming 257
One Hundred Per Cent. Water Bill Collection.....154
Operating Sewage Treatment Plants. 92
Operation of Direct Oxidation, A Year's 219
Organization, Pennsylvania State Highway. 1
Parkersburg, Water Supply for....237
Packing House Wastes, Activated Sludge for, at Mason City....262
Pavements, Resurfacing Old..55, 82, 118
, Rubber. 231
Paving Blocks, Tests for Granite...200
, Maintaining Wood-Block, in Peoria. 232
Stone in 1921.....32
Pennsylvania Highway Bridges.....233
Highway Equipment.....41
State Highway Organization. 1
Peoria, Maintaining Wood-Block Paving in.....232
Philadelphia, South Street, Bridge Piers. 84
Pier Construction, Wells Street Bridge. 174
Piers, Delaware River Bridge.....211
Pipe, Cement, in Alkali Soils.....244
Laying by Compressed Air....193
Lay Used Afford 236
Pipes, Cement Joints for Cast-Iron..194
, Sewer, Water-Tight Joints for. 165
Pittsburgh, Pa., Concreting Liberty Highway Tunnel.....198
, Restoration of Bigelow Boulevard. 26
Plans for State Health Board. Engineers'.....6, 27, 46
Pollution of the Delaware, Controling. 110
, Oil, of Waters.....260
, Stream, Investigation.....172
Positions Open, U. S. Engineering..228
Power Tunnel, Niagara Falls.....238
Precautions in Dumping Refuse.....154
Pressure Water Filters, Specifications for.....147
Preventing Scour at Bridge Abutments. 229
Prevention of Fire in Highway Bridges. 228
Profit and Loss in Refuse.....266
Protection Work, Strenuous.....32
Publication, Rochester Engineering Societies' 228
Public Stairways.....256
Utilities, Cooperation for.....245
Utilities During Coal Strike..180
Work, Day Labor on.....243
Works, State Indebtedness for. 202
Works to be Issued Monthly. 89
Pumping, Electric, at Concord.....238
Purification Water Typhoid and....227
Purifying Water, New Method of..197
Questionnaire for Bidders.....257
Radio in Highway Work.....116
Rainfall Intensity Curves.....176
Rating Water-Wearing Sands and Gravels, New Method of..... 64
Reconstruction, Brownsville Ave...144
Reciprocity in Registration of Engineers 182
Reduction, Garbage, in Dayton.....204
Refuse Collection Tables.....281
Disposal in Europe.....154
Disposal, Street Cleaning, and, Data. 270
Incinerator Letting.....157
Incinerators, Some.....285
, Precautions in Dumping.....154
Rental of Contractor's Equipment....191
Registration of Engineers, Reciprocity in 182
Repairing French Highways Necessary. 23
Reservoir, Baltimore Balancing.. 87
, Constructing Scituate.....137
, Floating Islands in Storage....195
, Wanaque. 143
Restoration of Bigelow Boulevard, Pittsburgh 26
Resurfacing Old Pavements..55, 82, 118
Rhode Island, Hydraulicking Earth in. 238
Ribs of Springfield Bridge, Constructing Arch.....6
Richmond, Ind., Garbage Collection and Disposal in.....251
River Bed, Water Main in, Eroded..160
, Delaware, Bridge Piers.....211
Intake Difficulties.....196
Road, Further Tests of Bates..... 5
, Drag, A New Type of.....158
Oiling in Wyoming.....257
Rollers, Cost of.....116
Test, Fourth Bates.....30
, Traffic on a Tennessee.....232
Work in N. C. Mountains..41, 101
Work, War Material for.....101
Rochester, Economical Subway Construction in.....234
Engineering Society's Publication. 228
Rockaway Boulevard, Building.....169
Rock Blasting, Skill in.....31
Rubber Pavements.....231
St. Louis Water Mains and Meters..152
Water Works Operation....102
Salaries for Sanitary Engineers....182
Salaries for Sanitary Engineers, Increased. 47
Sand, Blowing Fine Material from.. 40
Centering for Culverts.....171
-Clay Roads, Calcium Chloride for. 121
Disposal of Liquid Sludge....263
Filter at Chester, England....235
Sands, Water-Bearing, and Gravels, New Methods of Rating..... 64
San Francisco, Street Details in....230
Sanitary Engineers, Salaries for....182
Sanitating, Small City.....148
Scituate Reservoir, Constructing...137
Scour at Bridge Abutments, Preventing. 229
Sea Water and Wells.....260
Services, Water Works; Table..... 14
Sewage Effluents and Water Supplies. 114
Sludge, Treatment of.....217
Treatment at Johannesburg..218
Treatment for Scituate.....182
Treatment Plants, Federal Survey. 155
Treatment Plants, Operating.. 92
Sewerage and Water Works Systems, Plans for.....67
Sewerage Controversy, Louisville.. 48
Data, Tabulated.....205
Work, Data on.....114
Sewer and Street Work in Cincinnati. 117
Connections, Municipal Inspection of 160
Construction, Risky.....106
Joints in Wet Trenches, Cost of 261
Joints, Tests on Tight.....181
Maintenance 220
, Negley Run 39
Pipe Joints, Tight.....228
Pipes, Tight Joints in.....113
Pipes, Water-Tight Joints for.165
Sidewalks, Concrete, in Jacksonville 234
Shields, Widening Rock Tunnels in Service with Section.....48
Sludge, Activated, for Packing House Waste at Mason City..262
, Activated, in England.....151
Digestion at Birmingham....107
Digestion in Albuquerque....122
Digestion Tanks.....113
Digestion Tanks at the Baltimore Sewage Wks.....97
, Disposal of Activated.....111
, Land Disposal of Liquid.....263
, Study of Activated.....219
, Treatment of Sewage.....217
Small City, Sanitating a.....148
Soils, Alkali Cement Pipe in.....244
Under Loads, Settlement of... 5

Specifications, Pressure Water Filters 147
Springwood Bridge, Construction Arch Ribs of 8
Sprinting Ounce, Government 228
Stairways, Public 256
State Funds for City Streets 159
Incidentals for Public Wks. 32
Steel Water Mains in New Bedford. 165
Stone in 1921, Paving 32
Storage Reservoir, Floating Islands in 195
Stratford, Chlorination of Sewage in 133
Stream Pollution Investigation 142
Stream, Freak, in Wasnington 176
Street & Sewer Work in Cincinnati. 117
Cleaning & Refuse Disposal Data 270
Cleaning, Linear Units for Measuring 11
Cleaning; Tables 272
Details in San Francisco 230
Illumination 17
Lighting Construction & Apparatus 242
Lighting, Limits New 150
Manholes, Gas in 241
Streets, City, State Funds for 159
Study of Activated Sludge 219
Subway Construction, Economical, in Rochester 234
Sulphate, Copper, in Hartford Water Supply 240
Survey, Federal, of Sewage Treatment Plants 155
Tabulated Sewerage Data 205
Tank Moved on Flat Cars, 40,000-Gallon Steel 29
Tanks, Sludge Digestion 113
Taste from Gas Plant Liquors, Removing 12
Tax, Gasoline, for Motor Vehicles. 233
Tennessee Road, Traffic on a 232
, Memphis, River Intake Difficulties 196
Road 30
Testing Bridge Foundations 192
Tests for Granite Paving Blocks. 200
of Bates Road 5
on Tight Sewer Joints 181
Tight Sewer Joints, Tests on 181
Sewer Pipe Joints 228
Toledo Water Works Notes 178
Tractive Resistance on Roads, Study of 116
Traffic on a Tennessee Road 232
Treatment of Sewage Sludge 217
Plants, Sewage, Federal Survey of 155
, Sewage, at Johannesburg 218
Sewage, for Trenton 182
Trees for City Streets 67
Trenches, Cost of Sewer Joints in Wet 261
Trenton, Sewage Treatment for 182
Troy-Pocahontas Highway, Concreting 24
Trucks, Regulate Motor, or Destroy the Highway Which? 120
Versus Highways 115
Tunnel, Power, Niagara Falls 238
Tunnels, Concreting Liberty Highway. 198
, Rock, Widening with Section Shields. 48
Typhoid Fever from Clams 178
and Water Purification 227

Underground Uncertainties 47
U. S. Engineering Positions Open. 228
Units for Measuring Street Cleaning, Linear 11
University of Michigan Highway Courses 234
Unusual Sewer Construction at Fort Madison 222
Use of Base before it Sets 257
Fishes, Mosquito Control by. 195

Valves & Meters, Manholes 180
Vertical Fibre Brick, Laying 255

Walls, Core, in Earth Dams 241
Wanaque Reservoir 143
War Dept. gives Nevada Draglines. 253
War Material for Road Work 101
Washington, Freak Stream in 176
Water Bills in Boston 235
Water Bill Collection, 1005 154
Waltham, Flushing Sewers in 81
Water Lead in Cistern 204
Water Mains in New Bedford, Steel. 165
Mains in River Bed Eroded. 160
Mains and Meters in St. Louis. 158
Meters and Economy 159
, New Method of Purifying. 197
Purification, Typhoid and 227
Supplies & Sewage Effluents. 114
Supply, Copper Sulphate in Hartford 240
Supply for Parkersburg ..... 23.
Tight Joints for Sewer Pipes. 165
Works Operation, St. Louis. 102
Works Services, Table 14
Works Systems, Plans for Sewerage and 67
Works, Toledo, Notes 148
Waters, Oil Pollution of 260
Wear of Concrete 68
Wells, Sea Water and 260
Street Bridge, Pier Construction 174
Wet Trenches, Cost of Sewer Joints in 261
Widening Rock Tunnels in Service with Sectional Shields 48
Wood-Block Paving, Maintaining, in Peoria 232
Water Mains 91
Wool-Scouring Waste Water, Acid Treatment of 90
Works, Public, Pay Labor on 243
Wyoming, Road Oiling in 257

Legal News

Acceptance of Bid Before Adoption of Ordinance Authorizing Contract 168
Acquiescence by Taxpayers in Unauthorized Street Grading Will Prevent their Enjoining Collection of Assessments. 167
Advance by Contractor to Sub-Contractor Under Agreement for Reimbursement from Percentage Retained 208
Allocating Cost of Street Improvements, Statutory Provisions for 167
Ambiguity in Resolution and Plans for Paving Fatal to Proceedings 168
Assignee of Engineer's Fee Held Not Entitled to Recover on Quantum Meruit 168
Bids, Specifications for, Must Furnish Standard for Real Competitive Bidding. 208
Bills, Rule as to Deposits for Water. 168
Bonds, County Road Contractors', as Protection to Subcontractors. 168
, Protection of Material Men by Public Works Contractors 33
Brick & Cement Instead of Hard Brick for Manholes not Fraud, Use of 17
Care Required in Using Concrete Mixer in Street 247
Certificate Under Highway Construction Contract, Effect of Final 33
City Charter and Ordinances Fixing Minimum Wages for Public Work Held Invalid 247
Held not Liable for its Negligence or that of its Servants in Regard to Instrumentalities in Public Parks 247
Held Unauthorized to Make Unchangeable Rates for Sewer Company 246
City's Right to Require Specified Public Utility Rates After Expiration of Franchise 208
Claim, Material Man's, Against Road Considered Separately 167
Compensation to Highway Contractors for Extra Work Held Unconstitutional, Statute Authorizing Extra 33
Construction of Act Authorizing Issue of Warants to Pay for Construction & Maintenance of Public Roads 247
Contract, Effect of Final Certificate Under Highway Construction. 33
Held Not Exclusive, Garbage Removal 17
Contractor, Advances by, to Sub-Contractor Under Agreement for Reimbursement from Percentage Retained 208
Cannot Recover Assembly After Allowing Statute of Limitations to Run Against Tax Warrants, Street Improvement 17
Contractor Whose Work Has Been Accepted and Who is no Longer in Control of Sidewalk Not Liable for its Condition, Public Works 17
Contractors' Bonds, Protection of Material Man by Public Works 33
Contracts by Street Railway Companies to Repave Streets 247
Cost of Operation of Utility Acquired by Municipality 168
County Held Not Entitled to Recover Back Money Paid for Road Repair Material in Excess of Specifications 246
Road Contractors' Bonus as Protection to Subcontractors. 168
County's Right as to Retention of Contract Price to Satisfy Liens 246
Covenants, Public Contractor Held Liable to Private Party for Neglect to Perform 17
Damage to Contractor's Equipment by Construction of Dam 207
Delay, Landowner Cannot Object to Steps Taken by Drainage District and Contractor Resulting in 33
Delegation of Council's Power, Scale of Wages for City Labor (Wisconsin) 207
Deposits, Rule as to, for Water Bills 168
Drainage District and Contractor Resulting in Delay, Landowner Cannot Object to Steps Taken by 33
Duty to Have Temporary Sidewalk Obstructions Lighted 246
Supply Gravel (Gary, Ind.). 208
Engineer's Fees, Assignee of, Held Not Entitled to Recover on Quantum Meruit 168
Fire Protection, Kalsomined Window Sashes & Wired Glass Piers as a 167
Protection Service, Rates for Public 208
Forfeiture of Public Works Contract, Grounds of 167
Fraud, Use of Soft Brick & Cement Instead of Hard Brick for Manholes, Not 17
Garbage Removal Contract Held not Exclusive 17
Grading Contracts, Duty to Supply Gravel, Waiver of Time-Limit (Gary, Ind.) 208
Grounds of Forfeiture of Public Works Contract 167
Illinois Appellate Court, Damage to Contractor's Equipment by Construction of Dam 207
Appellate Court, Right to Operate Municipal Electric Light Plant 207
Issue of County Road Warrants Payable in Future Held Unconstitutional 246
Kalsomined Window Sashes & Wire Glass Windows as Fire Protection 167
Laborers Not Binding on Contractors, Subcontractors' Certificates to 17
Liability for Letting Public Works Contract Without Bond to pay for Material and Labor Only Attaches on Insolvency of Contractor 247
Light Furnished by One Section of a City, Taxes cannot be Levied for 208
Manholes Not Fraud, Use of Soft Brick and Cement Instead of Hard Brick for 17
Material Men by Public Works Contractors' Bonds, Protection of 33
Man's Claim Against Road Must be Considered Separately 167
Mistake in Estimate of Amount of Construction Work, Recovery on Quantum Meruit for Extra Work Required by Changes in Plans 167
Municipal Plant, Return to 168
Municipality, Cost of Operation of Utility Acquired by 168
May Dispose of Property Owned by It Not Appropriated to Public Use 248
Obstructions Lighted, Duty to Have Temporary Sidewalk 246
Operating Expenses and Taxes of Municipal Plants (Wis.) 207
Ordinance Authorizing Contract, Acceptance of Bid Before adoption of 168
Paving, Ambiguity in Resolution & Plans for, Fatal to Proceedings 168
Plans, Ambiguity in Resolution &, for Paving Fatal to Proceedings 168
Procedure Where no Bids for Street Improvement Received Cost as Fixing Necessity for Advertisement 248
Property Owner Can Bind Himself by Contract to Pay Contractor for Street Improvement 247

Protection to Subcontractors, County Road Contractors' Bonas as.168
Public Fire Protection Service, Rates for 208
Public Works Contracts Awarded in Fraction According to Grouping of Bids 246
Works Contract, Forfeiture of.167
Quantum Meruit, Assignee of Engineer's Fee Held Not Entitled to Recover on.....168
Question of Election by City of Option to Purchase Waterworks System 246
Rates for Public Fire Protection Service 208
Recovery on Quantum Meruit for Extra Work Required by by Changes in Plans, Mistake in Estimate of Amount of Construction Work 167
Resolution & Plans for paving Fatal to Proceedings, Ambiguity in.168
Return to Municipal Plant.....168
Right to Operate Municipal Electric Light Plant (Ill.).....207
Road Improvement Necessary, Finding by County Commissioners of Public Utility 33
, Material Man's Claims Against, Must be Considered Separately 167
Rule as to Deposits for Water Bills.168
Scale of Wages for City Labor, Delegation of Council's Power (Wis.) 207
Separate Departments of Municipal Plants Should Carry Own Burdens 207
Sidewalk Not Liable for Its Condition, Public Works Contractor Whose Work Has Been Accepted and Who is no Longer in Control of 17
Specifications for Bids Must Furnish Standard for Real Competitive Bidding 208
Statutory Provisions for Allocating Cost of Street Improvements.167
Street Grading, Acquiescence by Taxpayers in Unauthorized, Will Prevent Their Enjoining Collection of Assessments....167
Improvements, Statutory Provisions for Allocating Cost of.167
Subcontractors' Certificates to Laborers Not Binding on Contractors 17
Taxes Cannot be Levied for Light Furnished to Only One Section of a City.....208
Taxes, Operating Expenses and, of Municipal Plants (Wis.)..207
Taxpayers in Unauthorized Street Grading, Acquiescence by, Will Prevent Their Enjoining Collection of Assessments 167
Tax Warrants, Street Improvement Contractor Cannot Recover After Allowing Statute of Limitations to Run Against.. 17
Temporary Sidewalk Obstructions Lighted, Duty to Have.....246
Unchangeable Rates for Sewer Company, City Held Unauthorized to Make 246
Utilities, Public, Co-operation for..245
Utility, Cost of Operation of, Acquired by Municipality.....168
Value of Waterworks System for Its Purchase by the Municipality, Method of Ascertaining. 33
Vote of Majority of Qualified Electors of a City Must Include, What a. 248
Wages, Scale of, for City Labor, Delegation of Council's Power (Wis.) 207
Waiver of Time-Limit on Grading Contract (Gary, Ind.).....208
War Contracts Held Unconstitutional, Statute Authorizing Extra Compensation to Highway Contractors on 33
Water Bills, Rule as to Deposits for 168
Waterworks System for Its Purchase by the Municipality, Method of Ascertaining Value of 33
Window Sashes, Kalsomined, and Wired Glass Windows as Fire Protection 167
Wisconsin Council, Separate Departments of Municipal Plants Should Carry Own Burdens...207
, Operating Expenses and taxes of Municipal Plants 207
, Scale of Wages for City Labor, Delegation of Council's power.207
Zone System of Road Improvement Assessments Approved 247

Societies

Affiliated Technical Societies of Boston 209, 250
Amer. Assoc. of Engineers.....209
Assoc. of State Highway Officials 249
Public Health Assoc., Sanitary Section 250
Society for Municipal Improvements Convention 183
Society of Civil Engin'rs.169, 209
Society of Civil Engineers, Illinois Section 209
Society of Mech. Engineers Sectional Meetings.....249
Water Works Assoc., N. C. Section 169
Architects, Amer. Institute of, Chapters 18
Associated General Contractors....250
Boston, Affiliated Technical Societies of 209, 250
Calif. League of Municipalities Convention 209
Cement Association, Portland.....18
Chicago Engineers' Club 209
City Planning, National Conference. 18
Construction Council 36
Convention, Amer. Soc. for Municipal Improvements 183
League of Calif. Municipalities 209
New England Water Works...188
Engineering Societies, Federated American, The Amer. Council of the 37
Societies Oppose State Licensing laws 150
Society, Cleveland..... 37
Engineers, Amer. Soc. of Civil..... 36
American Soc. of Mech., Cincinnati Section of the..... 37
Club, Chicago 209
, San Francisco Post of the Amer. Military 37
, West Australian Branch of the Australian Institute of... 37
Federation Council 18
Four-state Section, A. W. W. A.....250
Good Roads Congress and Show...249
Ill. Section, Amer. Soc. of Civil Engineers 209
Intern. Assoc. of Street Sanitation Officials 21
League of Calif. Municipalities Convention 209
Natl. Highway Traffic Assoc.....250
Municipal League..... 21
New England Water Works Association 169, 188, 260
North Carolina Section, American Water Works Association....169
Society Conventions 181
Street Sanitation Officials, International Association of.....169
Water Works Association, New England 169

New Appliances

Archer-Ford Paving Mixer..... 21
Autocar Street Flusher and Sprinkler 22
Avery Track-Runner 24
Buses for Supplementary Service, Motor 19
Byers Truckcrane 24
Calco Automatic Drainage Gates.. 75
Chlorine Gas Producer 21
Continuous Excavation and Removal of Dirt..... 96
Fire Truck, 4-wheel..... 24
Ford, Trail 24
Gasoline Summer Train..... 76
G-K Pipe Jointer..... 24
Grader, 1-Man Power..... 24
Ideal Sewer Joint Compound..... 26
Iron Horse Street Cleaners and Snow Shovels 136
Jarmin Road Fixer 53
Lamotte Hydrogen-ion Comparator Set 96
"Little Giant" Pipe Wrench..... 75
Loader, Large Self-Feeding Bucket. 19
Machine, Hug Subgrading 19
New Combination Crane and Shovel. 22
One-Man Power Grader 24
Paving Mixer, Archer-Ford..... 21
Pipe, Prepared Joint..... 24
Power-Lift Road Razer..... 21
Prepared Joint Pipe 24
Redflex Warning Signals..... 22
Reinforced Concrete Pipe..... 55
Road-Razer, Power-Lift 21
Safety Meter Box..... 24
Sand and Gravel Pumps..... 53
Sewer Joint Compound, Ideal..... 26
Shovel, a New ¾-Yard Universal.... 38
Smith Excavator and Loader..... 96
Street Flusher and Sprinkler, Autocar 22
Subgraaing Machines, Hug..... 19
Sweeper, Springfield 19
"Talking Lamp" for Highway.....136
Trail-Ford 24
Trailer, Warner Semi- 26
Truck, Four-Wheel Drive, Fire.... 24
Truckcrane, Byers 24
Warner Semi-Trailer 26
Wearproof Signs..... 75

Authors

Brown, Chas. Carroll—"Illinois Experimental Highway Tests"...253
Clark, H. W.—"New Method of Purifying Water" 197
Collins, D. C. Newman—"Sewer Maintenance" 220
Davis, B. B.—"Garbage Collection and Disposal in Richmond, Indiana" 251
Dick, Albert N.—"Brownsville Avenue Reconstruction" 144
Geiger C. W.—"Street Details in San Francisco" 230
Hampsch, O. H.—"Preventing Scour at Bridge Abutments".....229
Hardenbergh, W. A.—"Sanitating a Small City" 148
Hastings, M. B.—"Street Lighting Construction and Apparatus" 242
McKinley, Robt. C.—"Laying Vertical Fibre Brick".....255
Maddock, R. A.—"Economical Control of Chemical Dosage in Filter Plants" 258
Moore, Prof. J. Percy—"Mosquito Control by Use of Fishes"...195
Pollock, Clarence D.—"Tests for Granite Paving Blocks".....200
Reynolds, L. B.—"Unusual Sewer Construction at Fort Madison" 222
Sanders, P. R.—"Electric Pumping at Concord" 238
Walser, M. H.—"Cost of Sewer Joints in Wet Trenches".. 261

"WATCH DOG"

FROST PROOF METERS

effect an enormous saving in labor and repairs

The Frost Proof Meter may be had in all sizes up to and including 1¼".

The frost plate or bottom cap is brass lined as an added protection to the working parts.

The cap is designed to break when subjected to undue strain. When this fracture occurs, only the plate is damaged, the measuring unit being saved from distortion by the play afforded by the loosened plate. Replacement is easy—the cap is removed, a new one is replaced, and all that remains to be done is to pull up the bolts.

A hammer is unnecessary; no blows are required.

Waterworks officials and superintendents will find our catalogue of special interest.

ACCURATE DURABLE DEPENDABLE

GAMON METER COMPANY

280-294 SOUTH STREET NEWARK, N. J.

Chemicals for Water Purification

We manufacture the highest grades of

Sulphate of Alumina

also

Chloride of Lime

and

Liquid Chlorine

Pennsylvania Salt Manufacturing Company

WIDENER BLDG. PHILADELPHIA, PA.

PUBLIC WORKS.

CITY COUNTY STATE

A Combination of "MUNICIPAL JOURNAL" and "CONTRACTING"

Vol. 53 July 1, 1922 No. 1

Pennsylvania State Highway Organization

Rational classification of responsibilities and operation by an interlocking system of executive management, construction and maintenance division, supplemented by township and automobile division and the auditing and accounting departments, totaling more than 500 staff employees required in 1921 for the expenditure of $13,000,000, maintenance of more than 10,000 miles, and construction of 678 miles of improved highways.

The State of Pennsylvania has an area of 80,000 square miles, much of which is mountainous, and a population of 10,000,000 served by about 100,000 miles of highways of which 10,200 miles are included in the State Highway System of primary and secondary roads constructed, maintained, improved and controlled by the State Highway Department with its headquarters located in the capitol building at Harrisburg.

Under the policy of the present gubernatorial administration extending from 1911 to 1923, the organization of the Highway Department has been perfected and extended and plans made for the expenditure of $50,000,000 on the construction during the four years of about 2,000 miles of improved hard-surface roads, of which 678.61 miles were completed during 1921, at a cost of about $36,000,000 while $9,500,000 was expended during the same year for maintenance; both in accordance with the general policies outlined in PUBLIC WORKS for November 19, 1921, where the principles governing the selection and improvement of state roads, types of roads adopted, and other features, were discussed.

POLICY

With a determination to utilize the resources and the activities of the Highway Department to the greatest advantage of the State, its organization and development, equipment and operation under Governor Sproul, former commissioner Louis S. Sadler and the present commissioner George H. Biles, have fully eliminated political interference and it has been conducted on rigid business principles with economy and efficiency so as to secure the most rapid, enduring and valuable results with safe and permanent construction calculated to develop the resources of the country, improve transportation and facilitate commerce by a wise combination of a great number of separate improvements properly selected and located for the combined interests of local and general welfare.

Abundant research and investigation have been made and continue to form the basis and direct the policy of the department so as to create high-class standards of construction materials, labor and equipment and a uniform application so as to insure the best results and greatest economy and interchangeability and permit the training of a great corps of skilled specialists.

The executive department has built up very comprehensive and elaborate bureaus and divisions operating harmoniously and accurately without interference and equipped with highly efficient systems and approved appliances for recording, editing, accounting and other operations, by which the progress of all work is duly posted and is available at all times for examination by inspection or rapid comparison for definite information.

Special study has been given to the selection and operation of a large amount of mechanical equipment and to the location, testing and approval of construction materials to utilize local supplies, reduce costs, and improve quality of roads.

The interests of the citizens and fair appreciative treatment of contractors have been equally considered and constant efforts have been made to select and train the personnel of the staff so as to develop special qualities and abilities for the mutual benefit of the employees and of the State, encouraging zeal and loyalty and stimulating and rewarding ambition.

The relation, combination and character of the different divisions and their bureaus are graphically indicated by the functional chart which shows the control through the executive division of the construction and maintenance divisions, each of them operating in 15 different districts into which the State is geographically divided, and the township and automobile division; also the direct control through the management division which is assisted by the auditing and accounting division.

EXECUTIVE DIVISION

The executive division, consisting of the commissioner and the assistant commissioner, which is mostly concerned with the policies of the department, exercises supervision over the entire organization.

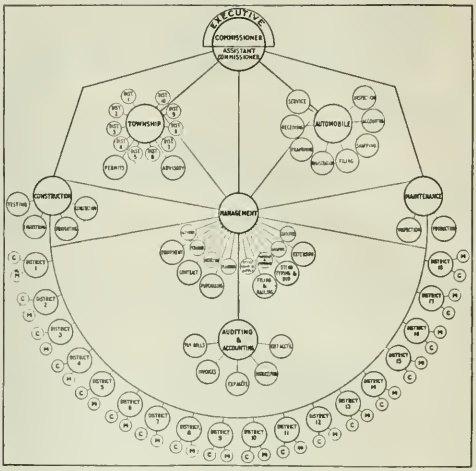
coordinates and controlls all activities of the department to the end of efficiency and the elimination of friction and duplication. The policies are determined at conferences with the heads of the other divisions who direct details and are held responsible for results.

MANAGEMENT DIVISION

The operation of the executive division is through the management division, which serves as a clearing house through which the policies are reduced to standard procedure for the construction, maintenance, township, automobile, and auditing and accounting divisions. This division employs the most up-to-date principles of industrial management. It determines the operations of the departments in accordance with the legal requirements that are formulated from a complete and careful analysis of the various statutes.

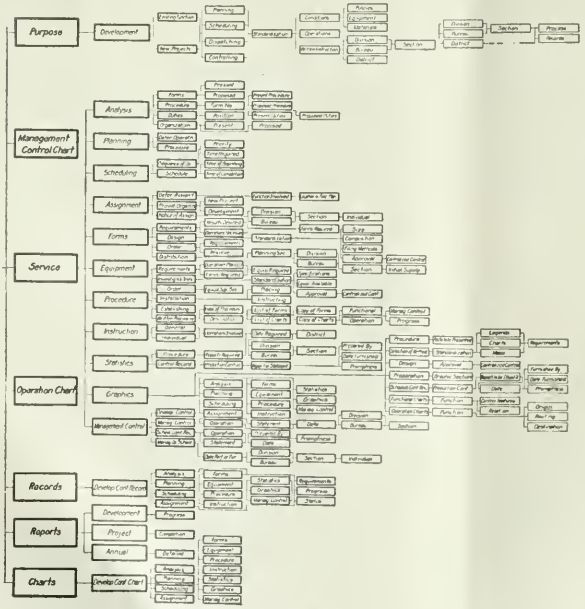
The management division schedules the performance of all phases of the department work and disseminates the schedules graphically and uniformly and follows them up, investigating all complaints and delays. It is represented at each department conference on investigation and research and supervises the combination of its findings from which standard methods of operation are devised for all phases of the department work.

It supervises the publication of all bulletins, periodicals, statements and reports and charts that tend to establish public confidence. It controls the system and methods of procedure in all other divisions and controls all the office equipment and supplies. It supervises the work of all interlocking and overlapping sub-divisions such as purchasing, equipment, contract, information, stenographic, typing, duplicating, filing, and mailing.



FUNCTIONAL ORGANIZATION CHART.

It provides complete record of the personnel of the department, adjusting differences, assisting and in general developing the employees to fill positions for which they are best fitted and where they can render the best services to themselves and to the organization. It prepares records and statistics of the organization and execution of all work on charts from which results and conditions can be easily seen by inspection and used for future estimates and decisions.



FUNCTIONAL CHART, MANAGEMENT DIVISION—PLANNING SECTION.

It has a purchasing bureau with a highly specialized organization fully informed on the price, location, quality, transportation and storage of great quantities of supplies and materials. There is a contract bureau with a legally experienced head to handle construction matters, an equipment bureau with a mechanical engineer responsible for the selection and inspection of equipment and instructions to operators for the execution of standard repairs.

There is an information bureau for the distribution of news to the public in a uniform and profitable manner, a stenographic, typing and duplicating bureau doing the work of the entire department (except the automobile division) and balancing extra demands in one place with diminished work in another so as to make a sort of clearing house and conduct the great amount of detail work with minimum constant force and without undue delay. The filing and mailing bureau handles all outgoing and incoming correspondence and classifies it with a simple system of unit symbols and divisions, with indexes which make all data immediately available in the different divisions and bureaus.

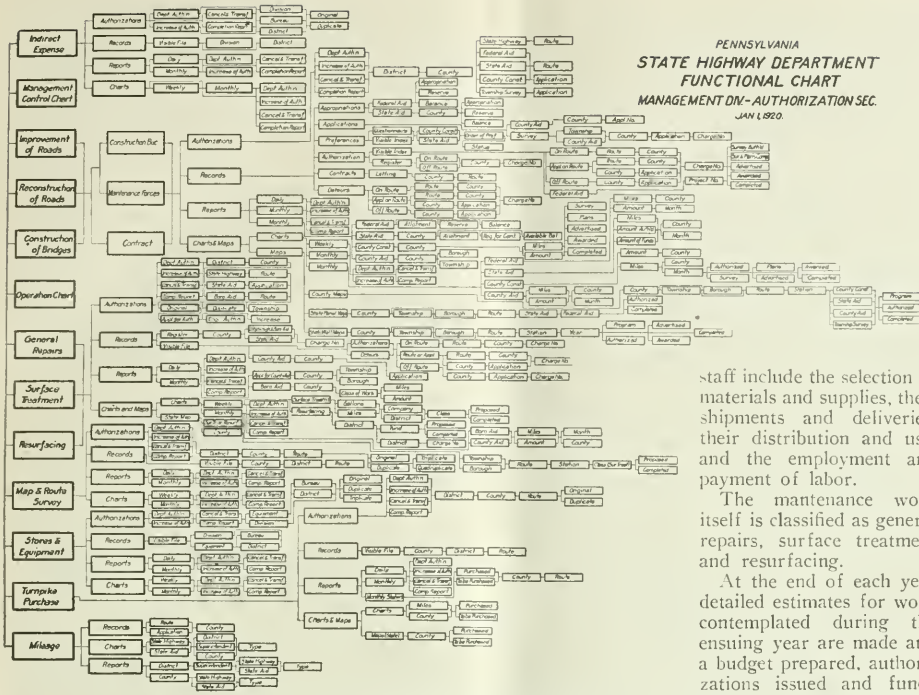


DIAGRAM SHOWING ELEMENTS AND CLASSIFICATION OF RECORDS AND OPERATIONS FOR CLASSIFIED SERVICE OF DEPARTMENT.

staff include the selection of materials and supplies, their shipments and deliveries, their distribution and use, and the employment and payment of labor.

The maintenance work itself is classified as general repairs, surface treatment and resurfacing.

At the end of each year detailed estimates for work contemplated during the ensuing year are made and a budget prepared, authorizations issued and funds set aside as early as possible.

CONSTRUCTION DIVISION

The construction division, on the whole, is organized similarly to that of the general organization of the Highway Department and is concerned solely with the building of roads and bridges, and the engineering problems thereof. The engineering section has quarters and officers for surveys, inspection and construction. The drafting section prepares plans and estimates, records of deeds of release, quit claims and the like.

The testing section has a fully equipped main investigating laboratory and corps of field officers, and besides testing materials used in construction does much investigation and research work to establish new sources of material and cooperates with the purchasing bureau in the acquisition and determination of new supplies in various localities.

MAINTENANCE DIVISION

This division is in charge of the upkeep of all state highways and all state aid roads and has a very large and efficient equipment, maintains great quantities of supplies and employs during the working season 10,000 men. Like the construction department, its territory is divided into 15 geographical districts each in direct charge of a district engineer and from two to four superintendents who are thoroughly trained. Their territories are frequently inspected, and instruction and advice are given regarding the use of standard methods employed under various conditions encountered. The duties of the

TOWNSHIP DIVISION

This division exerises a great influence on the expenditure of the ever increasing local funds and is an instrument of much educational value, especially in territories developing local systems of roads. It gives advice and has supervisory control of construction work and upkeep, training officials in standard methods and operations.

This division handles the distribution of state rewards to townships, rules and regulations governing the activities of townships, and issues permits for placing of sub-structures in the highways or telegraph or telephone poles, as well as the purchase of toll roads.

AUTOMOBILE DIVISION

In 1921 this division handled 1,297,136 applications for registration and licenses, with fees totaling as much as $230,000 per day and involving routine operations standardized to correspond closely with those of a great industrial or mercantile establishment. The receiving bureau receives the incoming mail and sorts and distributes it, examines applications, determines the sufficiency of the fee, audits the accounts, deposits the receipts and keeps records.

The registration bureau, which is the largest in this division, does a great amount of routine work and duplicating involving the use of a specially designed ledger sheet and file cards to give a conformity of record which requires the least amount of

typewriting and proofreading. It prepares from the application itself a registration certificate which is proofread to be exactly in accordance with the application, duplicated for numerous records and filed alphabetically and numerically according to the manufacturers' and engine numbers on the cards, thus assisting materially in the recovery of stolen vehicles.

The filing bureau handled last year about 2,000,000 cards arranged to give very prompt information on any subject recorded there and especially adapted to assist in the recovery of the large number of stolen vehicles reported. The shipping and mailing bureau is supplied with automatic machinery handling as far as possible the stamping of mail and the sealing and stamping of cards.

The inspection bureau enforces the law and safeguards the public with a corps of inspectors that patrol the highways and record infractions of the law. It revokes licenses, assists in the recovery of stolen cars and publishes lists of them and of registrations.

AUDITING AND ACCOUNTING DIVISION

This division handles and audits all disbursements of the department amounting to a maximum of more than $43,000,000 per year. The payroll bureau handles all salaries, investigates irregularities in the field, verifies the distribution of payroll costs and prepares vouchers to secure advances and reimbursements from the fiscal officers.

This division has an organization for checking and codifying expense accounts, audits, and pays invoices and verifies the distribution of all charges. It also keeps on file the vendors' records. Bookkeeping machines are used to register perpetual balances on all authorizations for which expense has been incurred.

DEPARTMENTAL ROSTER

The principal members of the staff in the different divisions include Commissioner George H. Biles, secretary Howard W. Fry of the executive division, chief engineer William D. Uhler, superintendent of construction Crosby Tappan, principal assistant engineer Harold E. Hilts, engineer of tests Horatio S. Mattimore, construction engineer Paul M. Tebbs, engineer of plans and surveys George H. Elsenhans, consulting bridge engineer Willis Whited, bridge engineer Emory E. Brandow of the construction division, township commissioner Joseph W. Hunter of the township division, assistant maintenance engineer William A. Van Duzer, and two inspectors in the maintenance division, registrar Benjamin G. Eynon of the automobile division, George G. Hatter, executive manager of the Management division and acting comptroller of the auditing and accounting division, Melville H. James, director of Extension division, and Frank O. Ewell, equipment engineer.

STAFF EMPLOYEES

The classification of the staff as shown by an elaborate organization chart includes, under the township commissioner, an engineer, assistant township engineers, inspectors, township clerk, permit clerk and general clerk.

In the construction department, a chief engineer, principal assistant engineer, engineer of tests, with assistant engineer, four plant inspectors, two road inspectors, 15 material inspectors, laboratory clerk, receiving and shipping clerk, file clerk, two stenographers, a typist, five cement samplers, a chemist, two assistant chemists, twelve laboratory assistants, one laboratory apprentice, one physicist, one assistant physicist, three laboratory assistants, one core-drill operator and one truck driver; a construction engineer, one office assistant, one construction clerk, one assistant construction clerk, and one progress clerk; an engineer of plans and surveys, with twenty-two draftsmen, two estimators, two stenographers, two clerks, and two blue-print operators; a bridge engineer, consulting bridge engineer, two assistant bridge engineers, one stenographer, nine draftsmen and an inspector; a superintendent of construction, assistant engineer, assistant superintendent of construction with eight clerks and eight time-keepers, a general construction clerk, requisition clerk, payroll and invoice clerk, equipment clerk, and general clerk.

The management division has an executive manager with twenty-two classified clerks, a contract clerk with two assistant clerks, a filing and mailing clerk, with five assistant clerks and messengers, a purchasing agent, an assistant purchasing agent with seven clerks, chief stenographer, thirteen stenographers, ten typists, multigraph operator, duplicator operator, two multigraph operators with two assistant multigraph operators.

In the extension bureau there are a director of extension, a field assistant and three clerks. In the equipment bureau there are an equipment engineer, chief inspector, three inspectors, equipment clerk and two assistant equipment clerks, a foreman and an assistant foreman, a mechanician, a storekeeper and two assistant storekeepers, shipper, vulcanizer and watchman, five chauffeurs, six mechanics, three mechanic's helpers, two leaders, ten truck drivers and a watchman.

In the auditing and accounting department there are a comptroller, tabulating clerk, paymaster, an invoice clerk, payroll clerk, file clerk, expense account clerk, three assistant paymasters, five assistant clerks, a bookkeeper and an assistant bookkeeper, general clerk, six bookkeeping machine operators and three key punch operators.

In the maintenance department there are an assistant maintenance engineer, two principal maintenance inspectors, chauffeur, maintenance clerk, progress clerk, report clerk, and two general clerks.

In the automobile department there are a registrar, an assistant registrar, chief inspector, inspector's clerks, correspondence clerk, personal clerk and about 150 clerks, inspectors, examiners, verifiers, typists and proofreaders.

In each of the geographical districts of the construction and maintenance departments there are an engineer, clerks, stenographers, chauffeur, and from twenty to forty chiefs of squads, instrument men, rodsmen, inspectors, assistant inspectors, clerks and chauffeurs.

The functions of the management division planning section are divided into seven principal classifications of purpose, i. e., management control chart, service, operation charts, records and reports chart with the different classifications indicated on the functional chart.

The functions of the authorization section of the management division are similarly divided into thirteen principal classifications: control chart, improvement of roads, reconstruction of roads, construction of bridges, operation chart, general repairs, surface treatment, resurfacing, map and route surveys, stores and equipment, purchase, mileage; with an elaborate system graphically shown on the functional chart.

Settlement of Soils Under Loads

Under this heading we gave last week a description of a machine proposed by the American Society of Civil Engineers for testing the settlement of different soils or of a given soil under applied loads. This should have been accompanied by an illustration which was inadvertently omitted and is given herewith and will serve to make the description more readily intelligible.

Further Tests of Bates Road

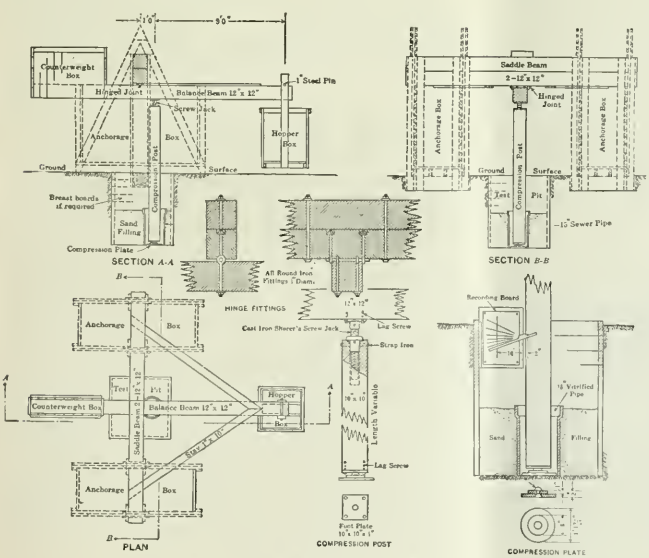
Result on the several sections of the third run of three thousand applications with 4,500 pounds on each rear wheel

The third traffic run made in testing the Bates experimental road (which was described in PUBLIC WORKS for February 5 and 19, 1921, and June 10, 1922) has been completed, as noted last week, the loads in this run being 4,500 pounds on each of the rear wheels of the trucks and 2,000 pounds on each of the front wheels, the increase of weight over that of the second run being obtained by piling brick in the rear end of the bodies. This load corresponds to 450 pounds per inch of nominal width of the rear tire and 400 pounds per inch of the front tire.

Exactly 2,000 applications of this load were given to the various sections in the daytime, the trucks travelling with the outside edge of the rear wheel 2½ feet from the north side of the pavement and at the extreme edge of the south side. At the completion of the daytime run it was noticed that the first five sections (composed of bituminous-filled brick on macadam bases of various thicknesses) were broken up to such an extent that it was practically impossible for trucks to travel over them with the assigned speed of 12 miles per hour. For this reason a turn-around was constructed at Section 5 and no further traffic was imposed upon the first five sections, which will be left in their present condition for inspection by visitors.

Following the daytime run of 2,000 applications, 1,000 applications were made at night at the time when the most extreme curling action exists.

At the termination of this third run the pavement had been subjected to 1,000 daytime round trips with 2,500 pounds on each rear wheel, 627 daytime trips with 3,500 pounds on each rear wheel, 540 daytime trips with the outside edge of the rear wheel 2½ feet from the edge of the pavement on one side instead of directly on the edge of the pavement as on the previous run, 1,000 daytime trips made like the previous one, but with one joint of each section of the pavement cut open, 1,033 night trips with loads applied as previously, 2,000 daytime trips with 4,500 pounds on each rear wheel, following the outside edge on the south side of the pavement and 2½ feet from the edge on the north side, and finally 1,000 night trips applied in the same manner to all but the first five sections.



AMERICAN SOCIETY OF CIVIL ENGINEERS MACHINE FOR TESTING SETTLEMENT OF SOIL.

As a load of 4,500 pounds applied 6 inches from the corners of a 4-inch rigid pavement produces a tensile fibre stress of up to 650 pounds or approximately the full strength of the concrete if the corners are considered as unsupported cantilevers, it was natural that all 4-inch rigid pavements failed under this load; and as this stress was approximately 65% of the strength of the concrete in a 5-inch pavement, which is above what is considered as the critical percentage to produce fatigue in concrete, it was expected that these also would fail.

Up to date complete failures are reported of the first six sections, four of which failed after 1,000 loads in the second run and two after 1,500 loads

in this run; Section 10 failed under the first increment of loading and Section 11 under the second increment. The first six sections were of bituminous-filled brick on macadam base. Of the asphaltic concrete pavement on macadam base, Sections 6 to 11, one had failed completely under the first load increment, another under the second, a third it was considered reached its maximum carrying capacity under the third loading, while such loading was considered in excess of the capacity of a fourth section. A few points of incipient failure appeared in the remaining two.

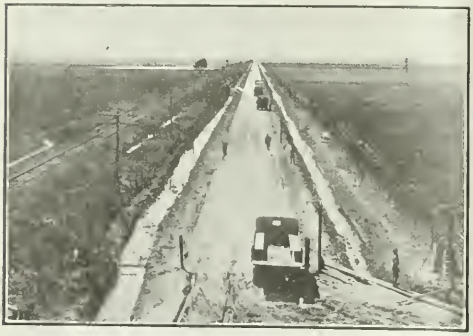
Of the asphaltic concrete on portland cement concrete base, there were few serious breaks, although "nature breaks" occurred in practically all of them. Most of them showed cracks in the curb and the adjacent edge at several points, although generally these did not appear to be serious. Four sections apparently reached their practical maximum capacity under the second increment of load. More or less cracking and corner breaks appeared in all the sections under the third increment.

Of seven sections of brick pavement constructed monolithic or semi-monolithic with a cement concrete base, one was considered a decisive failure under the first increment, two under the second increment, one under the third increment and three had not shown decisive breaks.

Of the 27 sections of cement concrete, 17 showed no apparent failures, although there has been more or less cracking in most of them. Of the remaining sections, three are considered to have failed decisively under the second increment and five under the third increment, while the others showed several cracks, but apparently no decisive failures as yet.

Under the third increment of load there were 26 decisive corner failures, of which 12 occurred during the day and 14 at night, 3 on the north side of the pavement and 23 on the south side. As more failures occurred during the thousand night applications than during the 2,000 daytime applications, this is taken to indicate almost conclusively that the curling action of the pavements makes the slabs more susceptible to failure at night than at any other time.

Until quite recently the subgrade has been very wet and its support of the pavement has not been such as would be considered desirable in most highway work. The accompanying photograph shows the side trenches standing full of water, and this was the condition until a very few weeks ago. This condition should be borne in mind in considering the effects of this test and comparing these results with those to be expected on other highways, the majority of which probably would be laid upon a much more solid subgrade.



VIEW OF BATES ROAD, SHOWING WATER IN SIDE DITCHES.

Engineers' Plans for State Health Boards*

Regulations of the State Boards of New Hampshire, New Jersey, New Mexico and New York, with respect to the matter and form of plans and reports required to accompany applications for water and sewerage permits.

New Hampshire—"We have never established any special rules regarding details of procedure on the part of cities and towns and their consulting engineers. Our general requirement includes (a) notification of this office concerning the project, with general statement, either oral or written, as to what this includes.

(b) Inspection and investigation by an engineer detailed by us, together with such preliminary analysis as may seem neessary or desirable.

(c) Submission of copy of construction plans and specifications.

(d) Approval thereof by the board prior to actual construction.

"As a rule, in connection with the inauguration of a new water works our engineer makes a rough preliminary survey of the situation (which is apt to include several propositions) and general advice is given as a prelude to securing the services of a consultant."

New Jersey—*Sewerage*—The regulations are the same as those for Arkansas (see page 322 of the May 6th issue), with the following minor exceptions: For profiles, the horizontal scale suggested is 100 feet to 1 inch. Plans showing street lines, location of Y connections, etc., under each profile are not called for. An additional requirement is the statement of the distance of sewer outlet from shore and depth of water there at mean tide, if an ocean or large stream.

Water Supply—The regulations are the same as those for Arkansas, except for the additional requirement that "If for purposes of fire protection it is necessary to provide by-passes, by which partly treated or raw water can be turned into the mains; they shall have valves upon them of such character that they may be properly sealed by the State Department of Health. These valves shall not be opened except in accordance with the provisions of Chapter 317, Laws of 1912." Also it is not required that the estimate of cost include "quantities with unit prices used for the different parts of the work."

*Previous articles of this series have appeared in the issues of April 8 and 22, May 6, 13, 20, and June 10 and 17.

New Mexico—Application for permission to install, modify or alter a water supply plant must be accompanied by "complete plans and specifications and a statement containing a general description and history of the existing or proposed water supply or system, or proposed changes therein, showing the geographical location thereof with relation to the source of the water supply, and all the sanitary conditions surrounding and affecting said supply and the works, system and plant; such plans, specifications and general statement to be in such form and to cover such matters as the State Commissioner of Health shall prescribe." The requirements for sewerage systems are practically the same. For either, the holder of a permit may be required at any time to furnish a complete report on the condition and operation of the plant, made by "a competent person."

New York—*Water Supply*—Petition to the Water Power Commission must contain a brief description of the project and statement of the quality, quantity, water rates, fire protection, etc., to be given by the proposed works and the sufficiency thereof for present and future requirements. Also "a statement of the assets and liabilities of the petitioner and, if a municipality or civil division, the total assessed valuation of all taxable property within the limits thereof and the total indebtedness thereof for (1) water supply purposes and (2) all other purposes. Also a statement of the estimated annual expenditure on account of the proposed works and the expected revenue." There shall also be "a general statement of all available sources of supply, with particular reference to their relative availability and probable cost, sufficiency and suitability, and the reasons for the choice of the particular supply for which application is made;" statements as to safety of proposed works, the sanitary condition of water from the proposed source and measures to be taken to protect this water from contamination or to purify it; the effect of the project on the water supplies of other municipalities with particular reference to the present and future needs of the inhabitants thereof; and provision for payment of all legal damages.

The petition must be accompanied by a general map of the system; a section of the U. S. Geological Survey topographical map showing the territory and water shed affected; detailed maps, drawings and profiles of proposed structures; engineer's report; map of lands to be acquired or occupied; detailed estimate of cost; estimate of annual expenditures and income; proposed schedule of rates; specifications for proposed structures; analyses of water; list of those who may be affected by carrying out the plans. Also an abstract of proceedings authorizing the project, containing certified copies of all petitions, minutes, resolutions, etc., of all boards or other bodies required to authorize the construction of the work and the making of the petition, and of oaths of office, bonds, etc., or other evidence required to show the authority of those verifying the petition.

The general map shall be drawn to "a suitable scale" and show the general matters which we have previously detailed as specified by other states, including elevations of all controlling points, among them crests and depressions in main pipe lines or aqueducts and locations of sewer outlets that may contaminate the supply. On the U. S. Geological Survey map shall be show nthe location of the proposed works, outline of watershed and location of territory to be served. If the watershed is on more than four sheets of these maps, only those showing the proposed works are required.

Profiles "to suitable horizontal and vertical scales" shall show each principal pipe line or aqueduct and computed hydraulic gradients for ordinary and for fire draft.

Plans are required of proposed structures, giving sufficient detail to enable the commission to determine the adequacy, suitability and safety of the designs. Estimates of cost shall give quantities and unit prices in sufficient detail to enable them to be studied and checked, and include cost of land.

A land taking map shall show lands to be acquired or occupied and rights of way, indicating buildings, roads, streams, topography and other important features. Map of reservoir site shall show surface contours in sufficient detail to permit capacity of reservoir to be determined accurately.

(To be continued)

American Construction Council

In our issue of June 3, we published an invitation addressed to all interested in the construction industry to attend a meeting in Washington with a view to organizing "The American Construction Council." This meeting was attended by about 170 representatives of the various groups concerned with construction and the meeting was opened by Secretary Hoover. Several addresses were made, all stressing the need of some agency to remove from the construction industry the many undesirable conditions attached to it.

An executive board was elected which will select the officers. The following were recommended by the conference: (1) The formation of a code of ethics acceptable to the whole industry and to the public; (2) Gathering of adequate statistics from all sources; (3) Reduction of the national shortage of building trade mechanics and the establishment of the necessary apprenticeship system; (4) Co-operation in establishing uniform building codes throughout the country; (5) Co-operation with railways in expediting the revision of existing freight rates on construction materials; (6) The establishing and strengthening of local organizations throughout the country to bring about the co-operation of all elements in conformity with the principles of the Council; (7) The investigation of the evils of seasonal employment and migration of labor; (8) The encouragement of local building shows; (9) Simplification and the elimination of waste; (10) Education of the public as to the desirability of a better distribution of its construction and maintenance requirements; (11) Promotion of health and safety for workmen and the reduction of loss of life; (12) The reduction of waste of construction materials from preventable fires; (13) The study of old buildings in order to establish superior methods of construction; (14) The education of the public as to the necessity and economy of properly maintaining structures.

Constructing Arch Ribs of Springfield Bridge

Thirty-five ribs containing 6,000 cu. yds. of concrete and 1,800 tons of structural steel and supporting the floor of the seven-span bridge across the Connecticut river, erected with a minimum amount of falsework, using structural steel reinforcement to support forms and concrete.

The bridge now being built across the Connecticut river from Springfield to West Springfield was described in the issue of PUBLIC WORKS for May 20th. As stated therein, it has seven spans varying from 176 feet to 110 feet in length. Each span has five reinforced concrete, parabolic, hinged arch ribs. Three of the arch ribs are grouped under the car tracks at the center of the roadway and the others are at the side lines. Each rib is reinforced by a pair of steel latticed girders with parallel chords, the two girders being connected by transverse bracing to form self-supporting arch ribs. Each rib is provided with permanent hinges at the haunches and a temporary hinge at the crown and acted during erection as a three-hinge arch, after which it was riveted together at the crown, thus transforming it into a two-hinge arch. The steel ribs support the forms and the rib concrete during construction and eliminate the expense, obstruction and delay that would be involved by the use of the ordinary river falsework, including trestle bents and arch centers. The spandrel walls and floor columns are supported directly by the ribs.

The structural steel for the arch ribs was fabricated at the shops of the McClintic Marshall Co. and each rib was shipped to the site in four sections which were field riveted either before or after erection to form a half arch. These quarter ribs varied in weight from about 17½ tons in Span V to 6½ tons in Span I. In the shorter spans, the quarter sections were riveted to form half sections before erection.

The seventy cast-steel pedestals resting upon the granite skewbacks and supporting the haunch hinges of the ribs varied in size, the largest being 9 feet 2 inches high, with base 5 feet by 6 feet 2 inches and weighnig about 4½ tons. These pedestals were set in position on the masonry by a lighter, being temporarily held in position by two 1½-inch bolts parallel to the face of the skewback and passing through transverse timbers above them, and were adjusted to a clearance of about ¾-inch from the dressed surface of the granite by means of four set screws (in the largest pedestal 3¼ inches diameter), threaded through the base of the pedestal and bearing on small plates on the surface of the stone. During the adjustment of the rib, the pedestal rested on a set of shims in a vertical plane through its center, forming a temporary hinge at right angles to the permanent hinge.

ERECTION AND ADJUSTMENT OF THE STEEL ARCH RIBS

The quarter ribs were delivered by a scow, in the case of the shorter spans being riveted to form half ribs on the deck of the scow, and were raised to position on temporary pile bent falsework by the derrick on the lighter. They were set in position with the lower end bearing on the hinge pin at the pedestal and the upper end resting on wedges at the crown on top of the falsework. The necessary transverse struts were put in to secure stability.

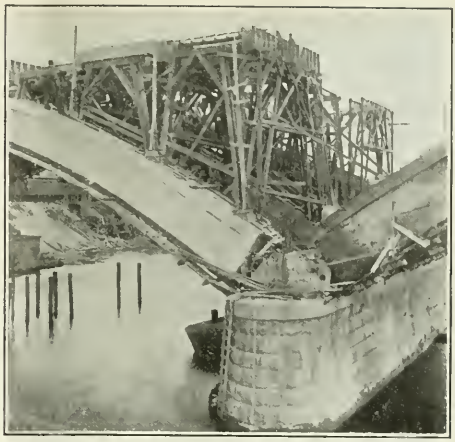
ERECTING END SECTION OF ARCH RIB REINFORCEMENT

Following the erection of the five steel ribs of any span, they were adjusted to position, the temporary falsework removed, and the weight at the crown transferred from the wedges to self-lowering jacks by means of which, together with the adjustment screws in the pedestals at the haunches, the crown pin was adjusted to the proper elevation, allowance being made for settlement and deflection. Owing to the care with which the ribs were set in position, but slight use was made of the adjustment screws, the adjustment being made with the rib bearing on the shims, and the screws set up later to take

a slight strain and to permit the pouring of melted antimonial lead (type metal) between the pedestal and the skewback, thus providing, after solidification, a uniform bearing surface for the pedestal. The large adjustment screws were later taken out and their holes filled with cement grout. Particular care was taken to make the final adjustments of the ribs when the effect of the sun was slight, either on a cloudy day or early in the morning. The deflections of the ribs under the greater part of the total dead load conforms closely to the calculations, the total being about 1½ inches.

The maximum unit erection stress in the arch rib steel was computed to be 9,820 pounds and the maximum unit stress in them under the dead and live loads of the finished bridge was computed to be 16,390 pounds.

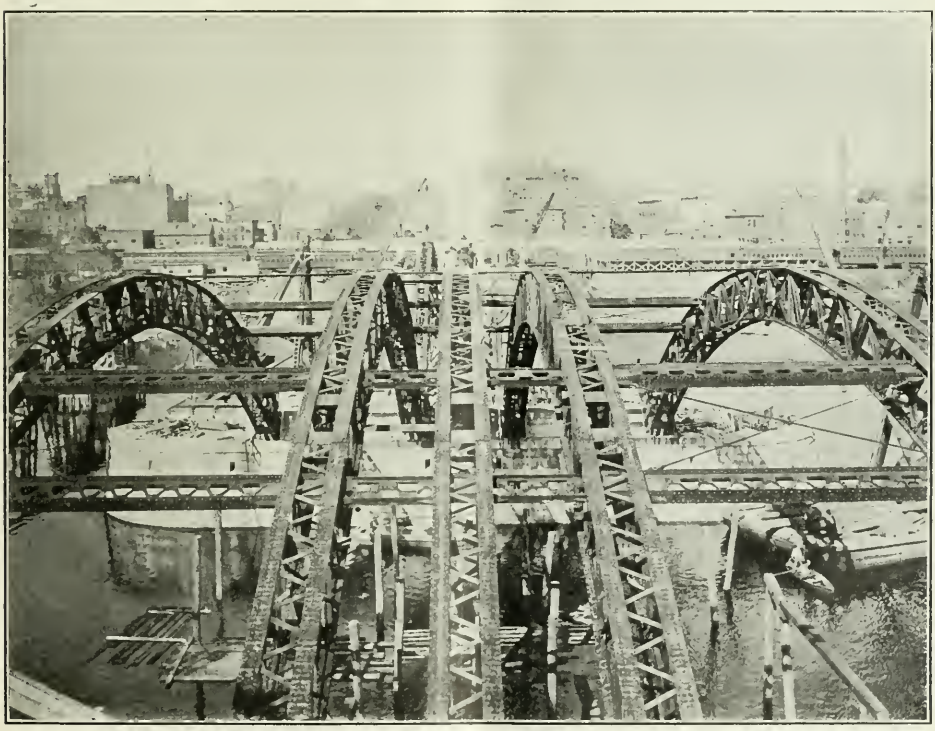
The use of structural steel reinforcement as a support for the rib during erection has not only the advantage of minimizing the amount of falsework in the river, but results in securing an initial compression in the reinforcement, thereby increasing the compression in the steel under final conditions. This results in considerable economy of reinforcement over a design using rods only, as in the latter case the maximum compression in the steel could only be "n" times the compressive stress in the concrete or about 7,200 pounds per square inch. The maximum compressive stress in the concrete is 593 pounds per square inch.



FLOOR FORMS SUPPORTED FROM ARCH RIBS.

SEQUENCE OF CONCRETING ARCH RIBS

In the arch ribs, the concrete was placed alternately on each side from the haunches to the crown and in no case did the concrete length of the two halves at any time differ by more than 10 feet. The pouring of each rib was a continuous operation.



REINFORCEMENT TRUSSES ERECTED AND READY TO SUPPORT FORMS FOR CONCRETE RIBS.

LOCOMOTIVE HAULING CONCRETE CARS ON SERVICE TRACK.

As the bridge was designed to permit the removal of the channel span and the substitution therefor of a draw span, the channel piers had to be designed to carry the entire thrust of the arches of the adjacent spans. Because the smaller piers were designed to withstand only a limited amount of unbalanced thrust and in order to insure that the thrust on the channel piers before the channel span was constructed might be similar in direction and as nearly as possible equal in amount to that which would obtain if a draw span were substituted, the concreting was done under certain limitations, viz:

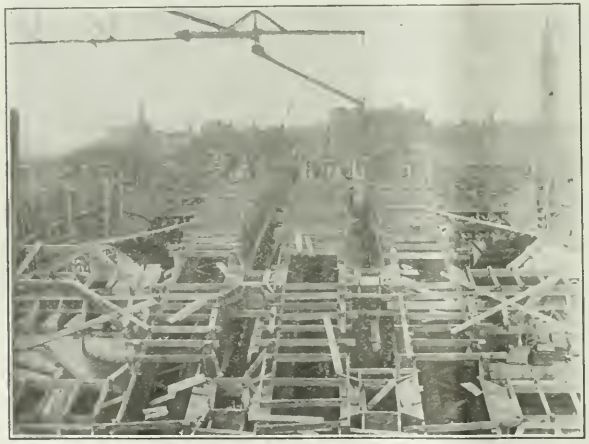
(a) In any span no rib was concreted until the steel for the rib in line with said rib had been erected in each adjacent span. (Except channel span.)

(b) In any span, the number of ribs concreted was not allowed to exceed, by more than three, the number previously concreted in either adjacent span, except that all ribs in the spans flanking the channel were concreted before any ribs were concreted in the channel span.

(c) No spandrel walls, columns or column bracing in any span were concreted until all ribs had been concreted in the adjacent channelward span.

(d) No rib of the channel span was concreted until all the ribs in the flanking spans had been concreted.

To secure approximately equal deformation of all ribs in each span and to prevent undue strain in the wind bracing between the ribs, the concreting of the superstructure was extended at all times across the full width of the bridge normal to the bridge axis.



FORMS FOR ARCH RIBS ENCLOSING AND SUPPORTED BY REINFORCEMENT TRUSSES.

PLACING CONCRETE

For the sake of appearance and because of the fact that the live load was relatively small on the face ribs, the hinges at the crown in these ribs were eliminated by riveting the half ribs together before any concrete was placed, thus forming these ribs into a two-hinge arch. The three interior ribs were transformed into two-hinge arches after the deck of the span had been concreted, a small section of the rib and a small piece of the deck being left out at the crown to permit of the necessary riveting after the deck had been poured. The form bottoms were attached to the bottom chords of the steel ribs by bolts which were later backed out; these bottoms carried the sides. All form work was done at the contractor's material yard about one-half mile up the river from the bridge, and was brought to the site on scows from the decks of which it was hauled into position by block and tackle. The average time required for concreting one arch rib was seven hours and the shortest time was five hours. Following the concreting of the major portion of the arch rib, which was carried only down to the haunch hinge pin, the block of concrete around the arch pedestal was cast, the joint between the two being made permanent by the use of roofing felt cemented together with asphalt. The outer surfaces of the face ribs were rubbed to provide a contrast to the surfaces of the spandrel walls above, which were given a rough pointed surface.

The ribs contained in all about 6,000 cubic yards of concrete and 196 tons of rod reinforcement in addition to the more than 1,800 tons of structural steel reinforcement. This concrete which formed a part of the 54,000 yards of the whole bridge was mixed in a central plant described in the June 17th issue and was delivered to the forms through chutes served by an elevating tower erected on a lighter. Concrete was delivered to the hopper at the base of this tower from cars hauled by gasoline locomotives and running on a track on a timber trestle paralleling the bridge. The lighter carrying the elevating tower could easily be moved along the trestle to form a flexible connection between it and the work.

The concrete of the arch ribs was commenced June 13, 1921, and except for the concreting at the crown of the center ribs of two spans, was finished in November. The floor slabs were also practically completed before work was suspended for winter.

Mailin-Belton Bridge Wreck

A flood in the Brazos river, Texas, washed out a portion of the west approach of a highway bridge which was being repaired with timber cribbing on May 6th, when the west abutment collapsed from undermining and wrecked a 300-foot truss span, drowning eight of the twenty people standing on it at that time. The bridge was built several years ago before the organization of the State Highway Department.

PUBLIC WORKS.

Published Weekly
at 243 W. 39th St., New York, N. Y.

S. W. HUME, President J. T. MORRIS, Treasurer

Subscription Rates
United States and Possessions, Mexico and Cuba $3.00 year
All other countries ..... 4.00 year
Change of Address
Subscribers are requested to notify us promptly of change of address, giving both old and new addressee.

Telephone (New York): Bryant 9591
Western Office: Monadnock Block, Chicago
A. PRESCOTT FOLWELL, Editor
FRANK W. SKINNER, Associate Editor

CONTENTS

PENNSYLVANIA STATE HIGHWAY ORGANIZATION. Illustrated 1
SETTLEMENT OF SOILS UNDER LOADS. Illustrated 5
FURTHER TESTS OF BATES ROAD. Illustrated 5
ENGINEERS' PLANS FOR STATE HEALTH BOARDS 6
The American Construction Council..... 7
CONSTRUCTING ARCH RIBS OF SPRINGFIELD BRIDGE. Illustrated 8
EDITORIAL NOTES 11
Linear Units for Measuring Street Cleaning—Special Features of Arch Bridge Construction.
Removing Taste from Gas Plant Liquors..... 12
DENITRIFICATION BY BACTERIA 12
WATER WORKS' SERVICES. Table 14
ASPHALT MACADAM IN KANSAS CITY. Illustrated 16
RECENT LEGAL DECISIONS 17

Linear Units for Measuring Street Cleaning

The article published by us last week in which the engineer of the San Francisco Bureau of Governmental Research advocated the use of linear rather than areal units for measuring performance of the several street cleaning methods is worthy of careful consideration, whether or not it is finally accepted. It would certainly seem that some unit is needed that will be generally accepted and will permit comparison between the street cleaning work done by different cities and using different methods and appliances. Certainly no such comparison can be made now that has any definite meaning or serves any useful purpose.

The linear unit has already been used to some extent. Two instances were cited by Mr. Witkin in his article. Fred Maag, of Cincinnati, uses a unit of 400 linear feet (presumably the average distance between intersecting streets) in measuring gutter cleaning. As Mr. Witkin has pointed out, most of the street dirt accumulates along the gutter, so that white wing cleaning is largely confined to cleaning the gutters—that is, to linear performance.

Undoubtedly there will be found difficulties and inconsistencies in this method also, but some at least of these can be avoided by adopting the suggestion of the author that both areal and linear units be used. The latter can be used in comparing the cost of operating two machines for doing the same work, even though operating on streets of different widths. But even in this case the area may enter in; as for example, if two sweeping machines are being compared that have brooms of different lengths and therefore cover areas of different width at each trip, the proper comparison of cost would seem to be on the basis of area cleaned rather than mere linear distance traveled, for the latter would unduly favor the narrower machine.

Again, even though most of the dirt may be blown into the gutters (and that condition is not so nearly approached in New York and other eastern cities as it seems to be in San Francisco), it is necessary in most cities, especially with old stone block or other rough pavement, for the sweeping machines to cover the entire area of the streets, usually in four or more trips; while a flushing machine may cover the entire area in two trips, but should not therefore be credited with performing only a half or a third as much work as the sweeper.

Again, even though most of the dirt is swept up in the gutters only, the width of the street affects the amount of dirt that collects there, especially perhaps in its effect on the amount of traffic that uses the street; and the labor of sweeping the dirt into piles and of removing it in wagons are both affected by the amount of dirt handled as well as by the distance traveled.

For these and other reasons it seems to us probable that area as well as length of street covered will need to be considered in any acceptable plan for comparing street cleaning work done.

Special Features of Arch Bridge Construction

The most successful engineering practice requires close co-ordination between the most efficient type and details of design and the safest, most rapid and economical plans and methods of its construction. The latter are largely dependent on local conditions which, in large structures, usually present new problems and often are important factors in determining portions of the design. The numberless variations of dimensions, proportions and requirements for the design, and the wide choice of apparatus and methods of construction provide for such a vast number of combinations that no two large jobs can ever be duplicated. The different elements of each job should be most carefully selected, matched, and adapted to each other to determine the smallest cost and the most advantages that can be secured by the large amount of patient skill and experience requisite for handling such undertakings.

Although there are often opportunities for ingenious and daring innovations, they are usually justified only when unavoidable, and the best results are undoubtedly obtained by wise selection of proved standards both of methods and equipment and their conservative development and modification to suit varying conditions.

Such a policy adopted for the $4,000,000 concrete

arch bridge at Springfield made for conservative treatment conforming to advanced practice and presenting new and interesting features that are valuable precedents for adoption, modification or suggestion in many kinds of construction work, even that which is not strictly similar to the Springfield Bridge.

Outstanding features of the work described in this issue and in previous articles, are the consideration given to the artistic and monumental features of the structure that derived beauty and symmetry from its mass, proportions and simple details with little extra expense; the co-ordination of finished members with the practical resources for their construction, the physical requirements suited to available resources, and the installation and operation of the construction plant with economic regard to local conditions and efficient operation.

Hand labor was eliminated and mechanical operations simplified by ample storage and by the handling of materials in continuous operation at central points and by powerful apparatus; the mixing and distribution of concrete by independent, continuous operations involving track service to hoisting equipment that was easily floated from place to place and made a flexible system of great capacity and easily controlled; the installation of the large amount of supplementary floating plant that could be cheaply and rapidly shifted and was adapted to the shallow water conditions; the preliminary development of the potential strength of the arch reinforcement to support the main spans themselves during construction and eliminate falsework; the accurate adjustment of the arch rib, its perfect control by dressing the two backs at the site and casting the pedestal bearings under working stress; a transformation of three-hinge construction arches to two-hinge service arches; the equalization of steel and concrete stresses in the ribs; and the elimination of temporary arch centers, their expense, difficulty of shifting and uncertainty of movement together with the impact and settlement of the permanent structure that may occur when centering is removed. These were all essential features carefully planned and satisfactorily handled in a manner promoting safety, rapidity and economy of construction and affording valuable information for the execution of subsequent work.

Removing Taste from Gas Plant Liquors

The seventh annual report of the Milwaukee Sewerage Commission contains some interesting information by Wm. R. Copeland, the chief chemist, concerning experiments made by the commission on the removal of tastes by activated sludge treatment.

Tests of the ability of the activated sludge process of sewage treatment to absorb and remove tastes from Milwaukee sewage caused by A.C. (ammonia condensation) liquor from coke and gas plants, showed that the effluent from the final settling basins contained little taste of consequence; and that such tastes as were noted could not be detected when this effluent was diluted with an equal volume of lake water. According to figures available, the volume of A.C. liquor in Milwaukee sewage will not exceed 1 per cent. of the sewage flow even if the coke gas works are doubled in capacity. As a result of these tests, the following recommendations were made: (1) "The activated sludge process of sewage purification will remove the taste of phenol from sewage which contains as much as 2 per cent. by volume of A. C. liquor; (2) the presence of 2 per cent. by volume of A. C. liquor in the sewage does not decrease the biological efficiency of the activated sludge in removing the suspended organic matter; (3) the number of bacteria present in the plant effluent is considerably greater when sewage contains 2 per cent. or more of A.C. liquor; (4) the A.C. liquor does not injure the quality of the sludge for pressing when that liquor is present in the raw sewage up to a volume equal to 2 per cent. of the volume of the sewage; (5) there are strong reasons for believing that the activated sludge process can handle Milwaukee City sewage and produce an effluent meeting the standard set by the commission when that sewage contains more than 2 per cent. by volume of A.C. liquor."

Attention is also called to the fact that the A.C. liquor treated in these experiments did not contain any oil of any imporance, but that wastes from gas works and other industries do contain oil which must be kept out of the city sewage or else it will destroy the action of the activated sludge process. It is recommended that a second series of tests be made in winter to make sure that the activated sludge will absorb and remove the taste of carbolic acid in cold water.

Denitrification by Bacteria

Abstract of report by K. Scheringa on work of the Netherlands Central Laboratory. In making water analyses, nitrogen determinations should be made as promptly as possible.

Although the present trend of opinion among sanitarians is from, rather than towards, the significance of the forms of nitrogen, it is believed that the summary presented by Scheringa of the present state of our knowledge of denitrification is worth quoting at length. A few experiments of his own are added.

Denitrification is an oxidation of organic matter at the expense of nitrate or nitrite. It is a form of organic purification. The fate of the nitrogen is very variable. Lafar distinguishes: (1) reduction of nitrate to nitrite and to ammonium; (2) reduction of nitrate and nitrite to N_2O and NO; (3) reduction of nitrate and nitrite with liberation of elementary nitrogen. (This is denitrification proper, in the narrower sense of the word); (4) conversion of nitrate nitrogen into organic compounds (nitrogen assimilation); and (5) liberation of nitrogen by decay of organic compounds. Many conflicting data on these processes are to be found in the literature. In part this is due to the very varying conditions in nature and to the fact that many organisms will behave very differently according to the environment.

Errors in estimating the extent of denitrification may easily occur in the following ways: (1) by as-

suming all the CO_2-free gas to be nitrogen, whereas hydrocarbons and hydrogen will usually be present also; (2) by the fact that air, especially that of laboratories, at times has much nitrate, nitrite, and ammonium, which are greedily absorbed by colloidal substances (soil, manure); (3) by the fact that nitrogen-assimilating bacteria are present in soil, and may, under certain conditions, fix appreciable quantities of atmospheric nitrogen; (4) because of the ready solubility of nitrous oxide in water, as a result of which its formation and solution will cause a disappearance of assimilable nitrogen without apparent liberation of gas; and (5) in view of the fact that the disappearance of the diphenylamine reaction cannot safely be assumed to signify that denitrification is complete—there may still be present organic ammonium compounds unacted upon.

Review of Literature on Denitrification. Lafar has collected a number of facts from literature, the chief of which are: (1) Nitrate reduction is a very usual property of bacteria; (2) the same organisms may, not improbably, with different pabulum, form N_2O and NO; (3) evolution of oxides of nitrogen has been observed in nitrate-fermentation of molasses; in "Tabakssaus"; in nitrate-containing urine; (4) Tacke has observed the simultaneous formation of free nitrogen and oxides of nitrogen; (5) Gayon and Dupetit show the effect of altering pabulum—in the presence of asparagine, NO is formed; otherwise, free nitrogen; (6) for denitrification proper, it is essential that the oxygen concentration be very low, and a sufficient amount of oxidisable organic matter be present; (7) physiologically, the process is the supplying of the respirational oxygen-requirement of the bacteria in oxygen-poor environment; and (8) in agriculture, loss of fertility by this process is not to be apprehended: for nitrification will only set in when most of the organic matter has been oxidised and air is abundantly present—conditions under which denitrification will not occur.

More recent workers are referred to, namely: (1) Van Iterson—who concludes that denitrification may occur even when the concentration of organic matter is extremely low. This may be of significance for water analysis; (2) Lohnis—who finds in nitrate-bouillon that inoculation with much soil retards the denitrification. Compare the retarding effect of clay on chemical denitrification, noted by Scheringa; also of significance for agriculture (Public Health Engineering Abstracts—Water Supplies, p. 8); (3) Stoklasa once more showed that in agricultural soil, with known denitrifiers present, there is yet in most cases no appreciable loss of nitrogen from nitrate fertilizer; (4) Beyerinck and Minkman—who report a number of gas analyses. It appears that with increased nitrate concentration, the proportion of N_2O increases; (5) Suzuki—who also finds N_2O formation—especially when growth is rapid; (6) Koch and Petit—who find that in moderately damp soil the nitrogen is assimilated; while in very damp soil, or in liquids, loss of nitrogen may occur; (7) Brown—who, working with four different pure cultures, found all to develop best in weakly alkaline media. Preliminary addition of nitrite did not affect the process. Heavy additions favored it; (8) Van Caren—who confirms Koch and Petit's results; and (9) Oelsner—who finds denitrification in soil of 40% water-content without addition of carbon compound. Denitrification results from air exclusion. For soil fertility therefore, limited moisture-content and high porosity are desirable.

Bacterial Dentrification in Water. Scheringa for his own experiments made use of Bacillus Pyocyaneus, cultures of which were available; these developed rapidly in Giltay medium, and reduced all the nitrate to nitrogen. Pure cultures isolated from soil and from horse manure by Scheringa were less active and unsatisfactory.

When Utrecht tap water with nitrate added is inoculated with B. Pyocyaneus with a little glucose, free growth at once ensues. No free nitrogen is formed, but abundant nitrate. This observation led to numerous experiments to determine which constituent of the Giltay fluid was essential for denitrification proper. It was found that: (1) simply adding phosphate to the glucose-nitrate mixture brings about rapid denitrification. Citrate acts similarly; (2) the further addition of magnesium salt to the glucose-nitrate-phosphate mixture caused a very great retardation; but mere traces of iron sufficed to inhibit this retarding effect; and (3) if only magnesium, or calcium, or iron-salt is added to the glucose-nitrate mixture the process, even after the lapse of several days, does not go beyond the nitrate stage. Van Iterson also found the course of the reaction to vary greatly with the conditions: in bouillon with 0.1% KNO_3, there was strong evolution of nitrogen —while, with 4% KNO_3, nitrate formation occurred.

A series of natural waters, with and without added nitrate was then tested as follows: the water was kept for two days at 35° in completely full 100 c.c. bottles—one bottle in each case with B. Pyocyaneus added, and one without. The results obtained were very variable: (1) in no case did B. Pyocyaneus denitrify strongly; in some instances it actually inhibited the denitrifiers naturally present; (2) Water with low organic content showed little change; and (3) with Vecht water, small nitrate additions led to the formation of ammonium; with larger additions, ammonium disappearance was the principal change.

From Scheringa's experiments, it can be concluded: (1) B. Pyocyaneus in natural water is a nitrite-former rather than a denitrifier; (2) loss of nitrogen may be expected when natural water, high in organic content is stored under warm conditions with exclusion of air.

Recapitulation: The various forms of combined nitrogen in solution in water are readily decomposed. When air is excluded and oxidisable organic matter present, many kinds of bacteria have the power to draw on nitrate or nitrite oxygen for their respirational requirement. The conditions for, and the course of, the various reactions ensuing are most variable, and are as yet but little understood. As end-products have been identified: nitrite, nitric oxide, nitrous oxide, free nitrogen, ammonium. Ammonium may also disappear. For the purposes of an ordinary water analysis, the free nitrogen and the lower oxides thus formed may be regarded as lost. Hence, when a determination of the various forms of combined nitrogen is desired, it should be proceeded with at the earliest opportunity; when delay is unavoidable, bacterial activity should be restricted to the utmost by cold storage.

(Abstract by Frank Honnan for the U. S. Bureau of Public Health "Engineering Abstracts")

Water Works Service

Continuation, from the May 13th issue, of tables prepared from data furnished by superintendents of nearly eight hundred cities.

Note: In the table, ci. means cast iron; cl., cement lined; gl., galvanized iron; gs., galvanized steel; gwl., galvanized wrought iron; i., iron; ll., lead lined; s., steel; wi., wrought iron.

Municipality.	Private (P.) or municipal (M) plant.	Services laid preparatory to paving, before needed for use. Are they required by city?	Kind of pipe specified.	Depth specified.	Trouble experienced with them after laying.
North Carolina:					
Mount Airy.....	M.	yes	...	2 ft.	losing location; serv. too small
New Bern.....	M.	yes	g.	3 ft.	rust due to inactivity of line
Rocky Mount...	M.	yes	1" g.	2 ft.	none
Salisbury	M.	yes	none	18 in.	some rust out
Wilmington	M.	yes	g. l. conn.	18 in.	very little
North Dakota:					
Fargo	M.	yes	¾" l.	7½ ft.	settlement pulls lead apart at corp. or curb cock
Grafton	M.	yes	l.	6 ft.	none
Valley City.....	M.	no	...	6 ft.	.....
Wahpeton	M.	yes	l.	7 ft.	none
Williston	M.	no	...	7½ ft.	none
Ohio:					
Ashtabula	P.	yes	s.	4 ft.	leak after 7 or 8 yrs.
Barberton	M.	yes	wl. l. gooseneck	4½ ft.	none
Barnesville	M.	yes	l.	4 ft.	none
Bryan	M.	no	...	3 ft.	none
Cambridge	M.	yes	l., now l.	3-5 ft.	leaks
Cincinnati	M.	yes	l.	3 ft. 6 in.	very little
Cleveland	M.	yes	l. to curb	5½ ft.	ordinarily none
Cuyahoga Falls	M.	yes	l.	3½ ft.	.....
Dayton	M.	yes	1" res. 4" bus.	5 ft.	none
E. Liverpool....	M.	not always	l.	4 ft.	none
E. Youngstown.	M.	yes	standard	4 ft.	none
Eaton	M.	yes	l.	4 ft.	none
Franklin	M.	yes	l.	3 ft.	none
Kenmare	M.	yes	l.	level with water line	none
Lakewood	M.	yes	⅝" l.—res. 1" l.—bus.	6 ft.	none but elect.
Lancaster	M.	yes	l. and l.	4 ft.	none
Lima	M.	yes	l.	3½ ft.	corp. cocks occasionally found corroded shut
Lorain	M.	yes	l.	2-3 ft.	none
Marysville	P.	no	l.	3½-4 ft.	none
Medina	M.	yes	l. and wi.	3½ ft.	frost
Middletown	M.	yes	⅝" l.	42 in.	none
Mingo Junction	P. (J)	yes	...	3½-4 ft.	none
Montpelier	M.	yes	l.	4 ft.	settling of soil breaking lead
Newark	M.	yes	wl.	4 ft.	none
New Boston....	M.	yes	l.	3 ft.	none
New Phila.	M.	yes	¾"	4 ft.	.....
Niles	M.	yes	⅝" l.	4½ ft.	none
Portsmouth	M.	yes	l.	3 ft.	none
Sandusky	M.	yes	l.	4 ft.	none
Springfield	M.	yes	l. and g.	4 ft.	some

Municipality.	Private (P.) or municipal (M) plant.	Services laid preparatory to paving, before needed for use. Are they required by city?	Kind of pipe specified.	Depth specified.	Trouble experienced with them after laying.
South Carolina—Continued					
Bennettsville ..	M.	no	l. and g.wi.	1½-2½ ft.	none
Camden	M.	yes	g. wi.	12-18 in.	none
Charleston	M.	no	...	30 in.	.....
Cheraw	M.	no pav.	...	...	.....
Clinton	M.	yes	¾"	2 ft.	none
Easley	M.	yes	g.	18 in.	none
Spartanburg ...	M.	yes	...	2 ft.	none
South Dakota:					
Aberdeen	M.	yes	l.	5½ ft.	none
Tennessee:					
Elizabethton ...	P.	yes	...	30 in.	wiped joint sometimes gives trouble and has to be replaced
Erwin	P.	yes	none	2 ft.	none
Greeneville	M.	yes	l.	18 in.	none
Lebanon	...	no perm. pav.	...	12 in.	deterioration at couplings
Memphis	M.	yes	...	18-24 in.	.....
Newport	M.	yes	l. gooseneck g. pipe	24 in.	.....
Shelleyville	P.	...	...	...	.....
Trenton	M.	no	l.	3 ft.	none
Texas:					
Austin	M.	no	...	18 in.	none
Big Spring	M.	yes	wl.	36-48 in.	none
Cleburne	M.	yes	l.	24 in.	none
Cooper	M.	yes	1" g.	14-16 in.	occasional leak at joints
Dalhart	...	no	...	3-4 ft.	freezing
Electra	M.	yes	¾" g.	18 in.	none
Hearne	M.	no	...	...	.....
Henrietta	M.	no	l.	26 in.	none
Mart	M.	no	...	...	.....
Paris	M.	yes	l.	...	wiped joints
Quanah	M.	yes	l.	24 in.	none
San Antonio ...	P.	yes	g.	2 ft.	.....
Smithville	P.	no	...	...	.....
Stamford	M.	no	...	...	.....
Sweetwater	M.	yes	...	18 in.	none
Teague	M.	no	...	...	.....
Texas City	P.	no	...	...	.....
Waco	M.	yes	½"-¾"-1"	3 ft.	none
Vermont:					
Barre	M.	yes	wi.	5-6 ft.	sometimes get plug.
Proctor	M.	no	...	...	.....
Springfield	M.	yes	¾ g. wi.	4½ ft.	none
Virginia:					
Charlottesville..	M.	yes	ll.	2 ft.	none
Harrisonburg...	M.	...	g.	2 ft.	none
Lynchburg	M.	yes	l.	3 ft.	none from frost
Martinsville....	...	yes	¾" g.	2 ft.	very little
Richmond	M.	yes	⅝"-1"-l.	2½ ft.	very little
Staunton	...	yes	...	2½ ft.	none

Tiffin	P.	yes	none	4 ft.	none
Wadsworth	...	yes	...	3 ft. 8 in.	none
Warren	M.	yes	l.	4½ ft.	.....
Willoughby	M.	yes	¾" g. l. gooseneck	4½-5 ft.	none
Youngstown	M.	yes	l.	4-5 ft.	occasional break by settling of earth
Zanesville	...	yes	l.	4 ft.	.....
Oklahoma:					
Cleveland	M.	yes	1" pipe	18 in.	none
Collinsville	M.	yes	l.	22 in.	rust
Hartshorne	M.	yes	l.	18 in.	none
Holdenville	...	yes	l.	2 ft.	none
Newkirk	M.	yes	l.	24 in.	none
Sand Springs	P.	yes	none	18 in.	none
Pennsylvania:					
Allentown	M.	no	l.	4 ft.	.....
Bloomsburg	...	yes	none	4 ft.	smaller; soft iron pipes clog in 15-20 yrs., requiring renewal
Catasauqua	M.	yes	wl.	4 ft.	none
Chambersburg	M.	...	...	...	.....
Chester	P.	yes	l.	4 ft.	stopped up at corp. cock
Contesville	M.	yes	l.	3 ft.	none
Connellsville	P.	yes	wl.	3 ft.	none
Coudersport	P.	no	...	...	.....
Corry	P.	yes	wl.	4½ ft.	very little
Downingtown	M.	yes	¾" l.	3 ft.	none
Duquesne	M.	no	...	36 in.	Iron in water clogs sew. every 10 yrs.
Ellwood	P.	yes	l. none	4 ft.	none
Emous	M.	no	...	3-4 ft.	.....
Hamburg	P.	no	wl. l. conn.	3½ ft.	none
Homesdale	...	no	...	...	.....
Huntingdon	M.	yes	g. laid in tile	3 ft.	none
Indiana	P.	yes	l.	3½-4 ft.	none
Jenkintown	P.	no	...	3 ft.	none
Jersey Shore	P.	yes	none	4 ft.	some rusted thru, leaks
Juniata	M.	yes	¾" g.	3 ft.	rusting from non-use
McDonald	P.	no	...	3 ft.	.....
McKees Rocks	P.	no	...	...	.....
Manheim	P.	yes	g.	3 ft.	none
Media	M.	yes	l.	3½ ft.	none
Meversdale	P.	yes	none	3 ft.	just filling with rust
Millersburg	P.	yes	none	4 ft.	none
North Braddock	P.	no	...	...	.....
North East	M.	yes	l. and g.	5 ft.	none
Reading	M.	no	...	4 ft.	.....
Red Lion	P.	...	...	4-5 ft.	sts. graded down causes freezing
Reynoldsville	M.	yes	none	3-3½ ft.	none
Ravensford	P.	no	none	3 ft.	none
Sayre	P.	yes	none	...	none
Shoresville	M.	yes	¾" g.	3 ft.	freezing
Sykesville	M.	yes	l.	4½ ft.	a few leaks
Tamaqua	...	no	l. 4 lbs. to foot in 4" l. or t.c. pipe	4 ft.	none
Tyrone	P.	no	...	3 ft.	none
Uniontown	P.	no	l.	3 ft.	none
Warren	P.	yes	l.	4 ft.	none
Wellsboro	P.	yes	¾" wl.	5 ft.	none
Wilkinsburg	P.	In few cases	l.	4-4½ ft.	90% prove to be wrong location and size
Williamstown	P.	no	none	...	elect. where trolley runs
York	P.	no	...	3 ft.	.....
Rhode Island:					
Woonsocket	M.	yes	l.	5-5½ ft.	none
South Carolina:					
Anderson	P.	yes	l.	24 in.	none
Batesburg	M.	no	...	18 in.	.....
Washington:					
Seattle	M.	option of prop. owner	...	24 in.	from st. improv. and elect.
Spokane	M.	no	...	...	.....
West Virginia:					
Charleston	P.	no	⅝" tap, ¾" sew., double head at curb	30-36 in.	none
Moundsville	P.	yes	none	3 ft.	only when large sewer settled, causing breaks
Salem	M.	yes	l.	20 in.	clogged with sedi.
Sistersville	P.	no	...	...	.....
Welch	P.	yes	none	3 ft.	leaks from grading
Wisconsin:					
Appleton	M.	yes	l.	5½ ft.	none
Clintonville	...	yes	l.	5½ ft.	none
Delavan	M.	yes	l.	5 ft.	frost
Fond du Lac	M.	yes	l.	6 ft.	none
Fort Atkinson	M.	yes	l.	6 ft.	none
Green Bay	M.	yes	l.	5 ft.	none
Hartford	M.	Yes, at owner's expense	¾"-l.	5 ft.	none
Janesville	M.	yes	l.	6 ft.	none
Jefferson	M.	yes	l.	6 ft.	none
Kaukauna	M.	yes	l.	5½ ft.	none
Lake Geneva	...	yes	l.	6 ft.	none
Madison	M.	yes	⅝"-¾" or 1" l.	5 ft.	leaks due to settlement, etc.
Manitowoc	M.	yes	½"	6 ft.	leaks due to insufficient slack in serv. pipe or defective fittings
Marinette	P.	yes	...	5-6 ft.	none
Menasha	M.	yes	l. or el.	5½ ft.	occasional breaks in wiped joints
Milwaukee	M.	yes	l.	6 ft.	none
Mineral Point	M.	no	...	...	.....
Monroe	M.	yes	l.	5 ft.	leaks at wiped joints in old serv.; use flanged connections now
Neenah	M.	yes	l.	4½-5 ft.	with wiped joints
New London	M.	yes	l.	6 ft.	some frozen
Park Falls	M.	yes	l.	7-7½ ft.	none
Platteville	M.	yes	5.-⅝"	5 ft.	none
Plymouth	M.	yes	l.	6 ft.	some froze when ground not properly replaced under sidewalks
Racine	M.	yes	l.	5½ ft.	none
Reedsburg	M.	yes	wl. g.	5 ft.	some broken goose necks
Rice Lake	M.	yes	g.	7 ft.	none
Richland Center	M.	yes	l.	6 ft.	none
Shawano	M.	yes	⅝" l.	6 ft.	none
So. Milwaukee	M.	yes	l.	6 ft.	none but elect.
Sparta	M.	yes	1" or larger	6-7 ft.	clogging, effect of mineral water
Stevens Point	M.	yes	¾" g.	6-7 ft.	none
Sturgeon Bay	M.	yes	l.	5 ft.	.....
Superior	P.	yes	l.	6 ft.	freezing; elect; leakage from defective curb stops
Tomah	M.	yes	g. wl.	7 ft.	none
Tomahawk	M.	yes	...	7 ft.	.....
Viroqua	M.	yes	l.	6 ft.	none
Watertown	M.	yes	⅝" l.	6 ft.	none
Warwatosa	M.	yes	¾" tap, 1" serv.	6 ft.	grad. connector breaking shutoff boxes
Wyoming:					
Cheyenne	M.	no	l.	5 ft.	.....
Evanston	M.	no pav.	...	...	.....
Rawlins	M.	yes	l.	5½ ft.	few breaks, mostly in wiped joints

Asphalt Macadam In Kansas City

By Fred Gabelman*

Applied to old water-bound macadam with crown reduced to 6 inches; also over wooden culverts

On the old waterbound macadam pavements of the boulevard system of Kansas City, Missouri, the Board of Park Commissioners adopted the standard crown of 12 inches for the standard width of 40 feet for roadways. With the waterbound pavements it was necessary to have a considerable crown to get the water off the pavement and into the gutter as soon as possible, to prevent washing and raveling of the pavement, especially on steep grades which are common on the hills of Kansas City. But with the advent of the rubber-tired automobile, the oiled surface and bituminous binder, a flatter crown was soon found necessary to relieve the slippery condition during wet weather. Moreover, the surface being waterproofed, there was not the need of so much crown. A crown of 10 inches was first adopted, but later a crown of 6 to 9 inches, dependent on the grade, was decided upon for 40-foot roadways, with corresponding ratio for crowns on 50- and 60-foot roadways.

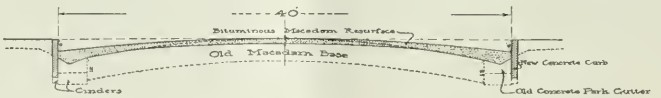
One of the most serious of the sharp crowns on a steep grade was corrected about eighteen months ago on Broadway Hill in Penn Valley Park. This roadway was of the standard 40-foot type, including the 30-inch concrete park gutter on each side, and with the standard 12-inch crown for the old water-bound macadam. The gradient was 7 per cent. This road is one of the main arteries for passenger traffic to the Country Club and southwestern residential sections of the city. With the increase of swiftly moving traffic the slippery condition of the oiled surface of the pavement on this hill was becoming more and more serious during wet weather and accidents were becoming of frequent occurrence.

To relieve this condition, the Board of Park Commissioners during the summer of 1920 resurfaced the pavement with bituminous macadam and flattened the crown to 6 inches. A concrete curb 6 x 20 inches was constructed just outside of the old park gutter, leaving the gutter in place. The grade of the curb was made the same as that at the center of the old pavement. The surface of the central portion of the pavement was scarified and excavated to a depth of about 3 inches at the center, tapering out near the quarter points, and the material removed.

Over the old gutter and macadam base was spread a layer of crushed limestone ranging in size from 1¼ to 2½ inches. After the stone had been evenly spread to the required depth and shaped to the proper cross section it was dry rolled until it was compacted and firmly keyed together, the surface being left open and porous to permit the penetration of the bituminous binder, all unevenness or depression corrected and rerolled until the surface was true to grade and section of the finished pavement. This course was 3 inches in depth over the central portion, but over the outer edges and gutters was from 5 to 7 inches in depth.

On this surface, when it was thoroughly dry and free from dust, an application of about 1¾ gallons of asphaltic cement was uniformly and evenly spread by hand, using fan-shaped lipped cans. The temperature of the asphalt at the time of application was from 300 to 350 degrees F. Immediately after the application of asphalt a layer of clean, dry limestone grit, ranging in size from ¼ to ¾ of an inch, was spread in sufficient quantity to completely fill all the voids and then thoroughly rolled until it was compacted and ceased to creep or weave under the action of the roller, and the surface was even and true to grade and section.

The seal coat of 2/3 of a gallon of asphalt per square yard, with a light dressing of grit, that is used in standard construction of the bituminous macadam by the penetration method to give a smooth finish, was left off in this work, so as to leave the surface without a smooth finish and therefore not so slippery. The asphalt used in this work was Texaco No. 96.



CROSS-SECTION OF ROADWAY ON BROADWAY HILL, KANSAS CITY

The result of resurfacing this roadway and reducing the crown to 6 inches has been that no accident has occurred since the work was completed, about eighteen months ago. The pavement is in splendid condition.

LAYING ASPHALT MACADAM ON WOODEN CULVERTS

Another bit of work of some interest is the construction of a bituminous macadam wearing surface across three or four wooden culverts in Brookside Boulevard and at The Paseo and Meyer Boulevard. These culverts are from eight to sixteen feet in length and of the same width as the roadway. A 3-inch oak floor is laid on a solid culvert frame with a 4 x 4 oak piece bolted on each side on the curb line to hold the pavement. A light coat of asphalt (the same grade as used on Broadway Hill, described above) is spread over the floor to waterproof and to preserve it. Then the standard bituminous macadam wearing course is constructed on this floor the same as on the macadam base, the depth being increased to four inches instead of the three-inch course laid on the macadam base. This carries the same pavement surface across the culvert that is on the rest of the pavement. In riding over the culvert in an automobile no jar is felt, and you do not know that you are going over a culvert with its usual jars and jolts. These culverts have been in use for from three to five years and have given splendid results with no maintenance.

*Engineer, Board of Park Commissioners, Kansas City, Missouri.

Recent Legal Decisions

PUBLIC WORKS CONTRACTOR WHOSE WORK HAS BEEN ACCEPTED AND WHO IS NO LONGER IN CONTROL OF SIDEWALK NOT LIABLE FOR ITS CONDITION

Where a contractor for the construction of a tunnel for a city was bound to keep the sidewalk during the progress of the work in the same condition it was in when the work was begun, and was responsible to the city during this time for any accident arising for the unsafe condition of the sidewalk, and was to keep it safe for travel for six months after completion of the work, it was held, Cunningham v. T. A. Gillespie Co., Massachusetts Supreme Court, 135 N. E. 105, that the contractor was not liable for injuries caused by a flagstone being one-half inch higher than the rest of the pavement, the accident happening four months after completion of the work and its acceptance; the work being no longer under the contractor's supervision and the care of the street above the tunnel being in the exclusive control of the city, upon which rested the duty of keeping the highway safe and convenient for travel. Responsibility of the contractor for the condition of the sidewalk was not to be inferred from the fact that the defect was reported to its superintendent.

STREET IMPROVEMENT CONTRACTOR CANNOT RECOVER AGAINST CITY AFTER ALLOWING STATUTE OF LIMITATIONS TO RUN AGAINST TAX WARRANTS.

In an action against a city by a street contractor it appeared that the contractor allowed the statute of limitations to run against tax warrants which he held under his contract against the abutting property before he commenced his action against the city, and it also appeared he had never made any effort to enforce these warrants. The Kentucky Court of Appeals holds, Knepfle's Ex. v. Town of Southgate, 238 S. W. 1051, that in such circumstances no action was maintainable by the contractor against the city for the cost of the street improvements, for that court has held (City of Louisville v. Hexagon Tile Walk Co., 103 Ky. 552) that the city is not liable to the contractor for such improvements until it has been found by a court of competent jurisdiction that the abutting property owners and such property are not liable to the contractor on the tax warrants for the improvements. In other words, the city is not liable for the costs of the improvement of a street which it has directed to be made, unless and until it has been determined by a court in a proper proceeding that the tax warrant or other lien attempted to be created by ordinance of the city is invalid against the abutting property; no action can be maintained until such proceeding is first had in a court of competent jurisdiction.

SUBCONTRACTORS' CERTIFICATES TO LABORERS NOT BINDING ON CONTRACTORS

The Arkansas Supreme Court holds, Arkansas Road Const. Co. v. Evans, 239 S. W. 726, that the Arkansas statute providing that a contractor's bond given thereunder for the faithful performance of public work inures to the benefit of those furnishing labor and materials and that an action may be maintained by one of such persons to recover for labor performed or material furnished in the fulfilment of the contract. But the subcontractor's certificate of the amount due by him to a laborer cannot be said to be an account stated in favor of the laborer against the principal contractor. The certificates of indebtedness do not bind the principal contractor and are, therefore, not assignable so as to permit the assignee to bring action upon them without the assignor being a party.

USE OF SOFT BRICK AND CEMENT INSTEAD OF HARD BRICK FOR MANHOLES NOT FRAUD

In a proceeding to enjoin the collection of sewer assessments, the plaintiffs relied, as evidence of fraud, on departure from the specifications, which required that in the construction of manholes hard brick should be used. At the time of construction, the only hard brick on the market was too hard for such construction. To avoid delay, the city and the contractor met the situation by the use of softer brick and cement, which had the approval of the engineer. The result was the full equivalent of what was contracted for, and the cost was substantially the same. There was neither deception nor bad faith. It was held, Lundberg v. Lake City, Iowa Supreme Court, 187 N. W. 384, that the departure from the specifications did not constitute fraud, and the assessment was valid.

PUBLIC CONTRACTOR HELD LIABLE TO PRIVATE PARTY FOR NEGLECT TO PERFORM COVENANTS

The New York Appellate Division, New York Pneumatic Service Co. v. P. T. Cox Contracting Co., 193 N. Y. Supp. 655, holds that contractors with a state or municipality in a public contract, who assume, for a consideration received from the sovereign power, by covenant, express or implied, to do certain things, are liable, in case of neglect to perform such covenant, in a private action at the suit of the party injured by such neglect, and such contract inures to the benefit of the individual who is interested in its performance. (Little v. Banks, 85 N. Y. 258,263). And this is true although the state or municipality might not be liable to the private individual (Markey v. County of Queens, 154 N. Y. 675,684). The obligation which does not rest on the assumption of a legal obligation is based on a moral one, which is enforceable in equity.

GARBAGE REMOVAL CONTRACT HELD NOT EXCLUSIVE

The Wyoming Supreme Court holds, City Sanitation Co. v. City of Casper, 206 Pac. 149, that a contract between a city and a sanitation company whereby the latter agreed to haul "all" the city garbage for two years, with the privilege of renewal from year to year for a period of ten years, the company to equip itself with the necessary appliances as required by a city ordinance, was not exclusive, and the contractor was not entitled to enjoin the city from entering into a similar contract with another contractor.

NEWS OF THE SOCIETIES

CALENDAR

July 12-14—NEW ENGLAND ASSOCIATION OF COMMERCIAL ENGINEERS. Exhibition. Auditorium Bldg., Springfield, Mass.

Aug. 15-17—LEAGUE OF IOWA MUNICIPALITIES. Annual meeting. Secretary, F. G. Pierce, Marshalltown, Ia.

Aug. 15-18—INTERNATIONAL ASSOCIATION OF FIRE ENGINEERS. Fiftieth convention. Municipal Auditorium, San Francisco, Cal. Secretary, James J. Mulcahey, Chief, Yonkers, N. Y., Fire Dept.

Aug. 28-Sept. 2—NATIONAL SAFETY CONGRESS. Detroit, Mich.

Sept. 11-15—ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS. New Auditorium, Cleveland, Ohio.

Sept. 12-15—NEW ENGLAND WATER WORKS ASSOCIATION. 41st annual convention. New Bedford, Mass. Secretary, Frank J. Gifford, Tremont Temple, Boston, Mass.

Sept. 25-28—SOUTHWEST WATER WORKS ASSOCIATION. Annual convention. Hot Springs, Ark.

Oct. 1-6—AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS. Annual convention. Cleveland, Ohio.

Oct. 16-19 — AMERICAN PUBLIC HEALTH ASSOCIATION. Annual meeting. Clevelnd, Ohio.

Nov. 15-16—NATIONAL INDUSTRIAL LEAGUE. Annual meeting. New York City. Secretary, J. H. Beck, Chicago.

Dec. 7-13—NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING. New York City.

FEDERATION COUNCIL

The executive board of the American Engineering Council of the Federated American Engineering Societies, besides adopting the report of its committee on Registration of Engineers, at its recent Pittsburgh meeting, discussed several other matters of national and international scope. Important features of the meeting were: the employment service now maintained in New York is to be turned over to the administration and control of the four founder societies; the committee on Regional activities reported progress toward a general plan for the affiliation of local or state organizations; plans were announced for the solution of national water power and forestry problems, and it was decided to lay the entire question of water power before President Harding; progress was reported by the committee on Work Periods in Continuous Industries in its investigation into the relative merits of three eight-hour and two twelve-hour shifts; it was decided to co-operate with other agencies in finding a solution of the national problem of flood control; and the matter of affiliation of American engineers with the engineering bodies of other nations was considered. Other subjects considered were jurisdictional awards in labor, patent legislation, an international engineering congress, aerial research, engineering representation on the Civil Service Commission, foreign relations, and waste in the agricultural industry.

OFFICERS OF THE AMERICAN INSTITUTE OF ARCHITECTS

The following officers were elected at the A. I. A. convention for the coming year: President, William B. Faville, San Francisco; first vice-president, E. J. Russell, St. Louis, Mo.; second vice-president, Robert D. Kohn; secretary, William Stanley Parker, Boston; treasurer, D. Everett Waid, New York City; and directors, William Emerson, Boston, B. W. Morris, New York City, and William L. Steele, Sioux City, Ia.

PORTLAND CEMENT ASSOCIATION

A regular meeting of the Portland Cement Association, with offices at 111 W. Washington Street, Chicago, will be held at the Hotel Traymore, Atlantic City, N. J., June 27 and 28. On the 27th the program will consist of the following papers: "Steel and Iron and Their Application in the Cement Industry," by W. R. Shimer; and "Quality Control in Cement Manufacture," by Richard K. Meade. On the 28th the regular so-called business session of the association will be held.

NATIONAL CONFERENCE ON CITY PLANNING

The 14th National Conference on City Planning, held at Springfield, Mass., on June 5-7, was attended by more than 200 city and consulting engineers. The meeting was featured by the few and well chosen topics and the full utilization of the time afforded for the discussion of them. Besides the papers, discussions on zoning were carried on at table during breakfast, lunch and dinner each day. The officers elected were Lawson Purdy, president, and Flavell Shurtleff, secretary. The 1923 meeting will be held at Baltimore, Md.

LECTURE BY PROF. ABRAMS

The Seattle branches of the American Society of Civil Engineers and the American Association of Engineers heard recently a discussion on scientific methods of making concrete delivered by Prof. D. A. Abrams of the Lewis Institute, Chicago, who is making a tour of the western states.

A. I. A. CHAPTERS

At the annual convention of the American Institute of Architects in Chicago recently the following chapters were granted charters: Central Illinois chapter, Peoria, Ill.; Erie chapter, Erie, Pa.; St. Paul chapter, St. Paul, Minn.; South Georgia chapter, Savannah, Ga.; and Scranton-Wilkesbarre chapter, Scranton, Pa. These chapters are offshoots from older chapters, and were formed by members who found it inconvenient to travel the distances necessary to attend meetings of the older groups.

PERSONALS

Bent, Arthur S., of Los Angeles, president of the Associated General Contractors of America, has been elected director for the Civic Development Dept., Chamber of Commerce of the United States.

Piepmeier, B. H., road engineer of the Illinois State Division of Highways, has been appointed chief engineer of the Missouri state highway department, succeeding A. W. Graham, who resigned.

Calkins, Bert H., has been appointed city manager of Albuquerque, N. M., succeeding James N. Gladding, who resigned recently.

Laylin, John, formerly with the state highway department, has been appointed superintendent of public works of Columbus, Ohio, succeeding E. S. Smith, resigned.

Terriault, H. A., formerly superintendent of water works, has been appointed director of public works of Montreal, Canada, to succeed A. E. Doucet, resigned.

W. F. Strouse, chief engineer of the public service commission, Baltimore, Md., has been made valuation engineer, and H. Carl Wolf, assistant engineer, will be made chief engineer.

Lahishiner, Jacob, has been appointed city engineer of Amsterdam, N. Y.

Shirley, H. G. has been appointed chairman of the new State Highway Commission by Governor Trunkle of Virginia. Mr. Shirley, now county engineer of Baltimore county, Md., was made state highway engineer of Maryland in 1912. He represented the American Association of State Highway Officials on the Highway Transport Committee of the Council of National Defense and was secretary of the Federal Highway Council, Washington, D. C. He was the first president of the American Association of State Highway Officials, has had experience in field work with the New York Central and with the Baltimore & Ohio railroads and is a veteran

Nicolet, T. W., has opened an office in Pittsburgh for landscape architecture and town and city planning. He has formerly been a member of the faculties of the Universities of Nebraska and Illinois, has engaged in private practice, and was in the Engineering Branch of the Construction Division of the United States Army.

Howe, Dr. Henry M., professor emeritus of metallurgy at Columbia University and past-president of the American Society for Testing Materials, died on May 14, at his home in Bedford Hills, N. Y., in his seventy-fifth year.

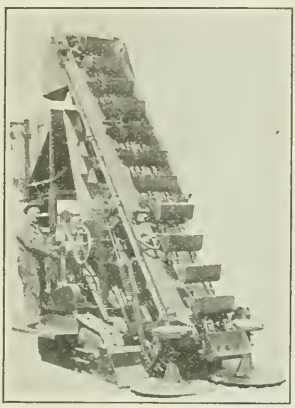
Bradish, George P., city engineer of La Crosse, Wis., for the past fifteen years, died recently after an illness of less than an hour.

New Appliances

Describing New Machinery, Apparatus, Materials and Methods and Recent Interesting Installations

LARGER SELF FEEDING BUCKET LOADER

The Barber-Greene Co. announces that it is now ready to supply a bigger and better self-feeding bucket loader with a capacity increased from 1-1/4 to 1-3/4 cubic yards per minute. This new machine, model 42, has the same type of disc feeder that distinguished the first Barber-Greene machine and here consists of two 36-inch flat steel discs placed in a horizontal plane at the lower end of the boom and driven by gears so that they both turn toward the center, thus bringing the material to the bucket and providing a better arrangement for controlling the discs. A measuring hopper with a varying capacity up to 21 cubic feet can be furnished for the use of road contractors although the standard equipment is a swivel spout that can be turned from the operator's platform. Another new feature is the adoption of the standard Cotta truck transmission giving 3 feet forward and one reverse.



BARBER-GREENE SELF-FEEDING BUCKET LOADER.

Traction is provided by crawlers having 60x10-inch continuous treads operated by 2-inch Diamond drive chains and equipped with special hubs provided with a bolt that breaks when too much strain is put on the crawlers. All moving parts of the crawler are completely protected from mud and dirt by a tight housing. A combination scraper and shoe assures practically a 100 per cent. pickup, and skirt boards protect the operator and machine from material falling from the bucket.

Hand wheels are provided for adjusting the elevator to desired digging level or raising it from the ground when traveling and for making fine disc adjustment causing the discs either to dig in or ride out of the material as required. Part of the weight of the elevator and digging end is supported by heavy springs. Abundant power is provided by the Buda Model M U Truck Type 4-Cylinder Gasoline Engine.

The crawlers are controlled by two levers and the elevator by a third and all the controls are easily reached by the operator who rides on the machine. The machine is steered through two independent clutches, one controlling each crawler, enabling the machine to turn around in the length of its crawlers. The length over all is 7 feet 9 inches, width at discs 6 feet 4 inches, discharge height 9 feet 6 inches, maximum height in working position 16 feet 9 inches, minimum height for shipping 10 feet, approximate weight 11,000 pounds.

THE SPRINGFIELD SWEEPER

This machine, manufactured by the Springfield Motor Sweeper Co., is constructed on new principles differing radically from those embodied in the design and construction of the pick-up sweepers on the market, and is intended to overcome the principal objection to other types that have excessively wide pick-up brooms and elevators and use wooden brushes that require frequent replacement.

In this machine the patent side brushes first sweep the material collected into a windrow that is picked up by a broom 3 feet wide and delivered to the elevator belt, thus eliminating the necessity for large brooms and conveyors 7 feet or more in width.

The material is handled by steel brushes, that, unlike wooden brushes, do not require renewal every few days. The sweepings are delivered to a pivoted dumping box which easily and quickly discharges them from the rear of the machine.

MOTOR BUSES FOR SUPPLEMENTARY SERVICE

Some electric railways now utilize the motor bus as an economical means for extending service and better serving the public and indications are that they ultimately will become large users of the gasoline carrier. Railways in a number of cities have purchased buses for the establishing of feeder lines, and initial experiments have proved so successful that many roads after giving the bus a thorough trial have decided to greatly increase their bus equipment. The bus offers an excellent cross-town transportation medium and is far less costly than equipment necessary for the operation of electric cars.

The Milwaukee Electric Railway & Light Company has 18 White buses in service and nine more on order which will be put on the road within the next few weeks. Three of them are in interurban service between Milwaukee and Waukesha. Other electric lines having recently purchased White motor buses are the Northern Ohio Traction & Light Company, Akron, 13; the Rockford & Interurban Railway, Rockford, Ill., 6 and the Pennsylvania-Ohio Electric Company, 5. All five of the P.-O. buses will be used in interurban service. The great majority of these installations are the White Model 50, a bus designed especially for passenger transportation.

HUG SUBGRADING MACHINE

This machine, equipped with grader blades, makes a smooth, flat grade or a smooth, crowned grade to the exact required specifications, which will get any inspector's approval. The machine is of simple, positive construction, and is sturdily built to secure maximum effi-

SPRINGFIELD MOTOR SWEEPER.

HUG SUBGRADING MACHINE WITH SPECIAL CRANK AXLE AND WHEEL ATTACHMENT.

ciency and minimum maintenance. The alignment of the machine is maintained by means of a coulter at rear of each end. Leaves surplus earth in windrows for filling up low spots used on industrial as well as on truck haul jobs. It can be quickly placed on and removed from road forms and subgrade.

It is claimed that it pays for itself on first half mile of road in savings effected. Crank axle and wheels provide easy transportation.

This machine will save the labor of ten men a day. Trims the subgrade true to grade. Cutting depth is easily adjustable. Special crank axle and wheels provide easy transportation. Manufactured by the Hug Company.

INDUSTRIAL NOTES

The Marck Engineering & Contracting Company, which for the past three years has been operating in the West Indies with offices in Santo Domingo, has opened offices in Brooklyn, N. Y., through which it expects to facilitate movement of American materials and machinery for work in Latin America.

The New Jersey Concrete Products Corp. has taken over the factory of the Pre-Cast Concrete Co., near Dover, N. J. In addition to pre-cast structural concrete and ornamental stone, the corporation, whose factory is in Dover and executive office in New York City, will supply other concrete products, such as building tile, face and common brick, etc.

H. L. Schwartz, formerly of Schwartz & Pease, Philadelphia, has opened an office in that city, where he will continue to represent the American Well Works of Aurora, Ill., and the Dean Brothers Steam Pump Works of Indianapolis, Ind.

H. H. Hunter will be associated with L. S. Kuhn of Bloomington, Ill., on highway construction work, following his resignation from the State Highway Department. The new firm is at present engaged in road work at Wataga, Knox County.

The Lakewood Engineering Co., Cleveland, Ohio, announces that the Contractor's Trading Co., Inc., will handle their building construction equipment exclusively.

The Barber Asphalt Paving Co. has changed its name to the Barber Asphalt Co., this change involving no alteration in the organization or obligations of the company.

George S. Hedge and Frederick W. Mattheis have organized the Hedge & Mattheis Co., with offices at 50 Dorchester Ave., Boston, Mass., to deal in construction equipment.

The Decatur Bridge Co., Decatur, Ill., and the Christopher & Simpson Iron Works Co., of St. Louis, have combined to form the Mississippi Valley Structural Steel Co. W. M. Wood of Decatur, Ill., is president of the company and C. R. Dick, secretary.

Chicago Engineering Associates has been decided upon as the new name for an association of existing organizations to render engineering and construction service, with offices in Chicago. James N. Hatch is chief engineer for this association and Edward N. Lake, general manager.

James I. Vincent has been appointed Eastern representative of the Chicago Bascule Bridge Company with offices at 30 Church street, New York. From 1912 until very recently Mr. Vincent was Eastern representative of the Strauss Bascule Bridge Company, in charge of the New York office.

The Rennolds Equipment Co. has been organized by A. Rennolds, formerly with the Equipment Corporation of America, with offices in the Lumber Exchange Bldg., Chicago, where it will handle a complete line of contractors' equipment and will buy slightly-used machinery to rebuild, sell or rent.

The Michigan Valve and Foundry Co. has purchased the business of the Flower Valve Manufacturing Co., manufacturers of fine hydrants, valves and hydraulic supplies at Detroit, and expects to continue the business along the same lines.

Adams, James C., has resigned as deputy city engineer of Binghamton, N. Y., to enter the contracting field.

FIRE-PROOFING & GRANOLITHIC COMPANY

The principals of the staff of the former Roebling Construction Company that developed cinder concrete as a fireproofing material and introduced it in New York City in 1895-96 are now organized as the Fire-proofing and Granolithic Company, Inc., 331 Madison Avenue, New York. They are prepared to supply any of the cinder concrete floor slabs approved by the New York Building Department and to contract for all kinds of granolithic cement work.

REMOVAL ANNOUNCEMENT

The general offices and show rooms of the following companies are now located at 41 East 42nd street, New York City: The Iron Products Corporation, the Central Foundry Company, Central Iron & Coal Company, Chattanooga Iron & Coal Corporation, Molby Boiler Company, Central Radiator Company.

Iron Products Corporation, New York, and its subsidiaries, the Central Foundry Co., Central Iron & Coal Co., Central Radiator Co., Molby Boiler Co., announce the opening of a district sales office in the Jefferson County Bank Building at Birmingham, Ala., June 1, 1922.

Langthorn & Smith, Inc., engineers and builders, 120 Liberty street, New York, announce their incorporation for carrying on the building business formerly conducted by C. H. Smith. J. S. Langthorn, president, member American Society of Civil Engineers; C. H. Smith, vice-president.

Orton & Steinbrenner Co., manufacturers of locomotive cranes, grab buckets and coal crushers, have moved their offices from the eleventh to the nineteenth floor of the Transportation Building, 608 So. Dearborn Street, Chicago.

Mr. A. P. Blackstead, formerly chief engineer of the Camden Iron Works (R. D. Wood & Co.), Camden, N. J., and prior to that hydraulic engineer with the Henry R. Worthington Company, New York, has joined the engineering staff of the Dayton-Dowd Company, manufacturers of centrifugal pumps and approved underwriters' fire pumps.

Hirsch, John G., formerly supervising engineer for Lockwood, Green & Co., engineers, Chicago, Ill., and Stone & Webster, Boston, Mass., has become associated with the Benham Engineering Co., consulting engineers, Kansas City, Mo., as principal assistant engineer. Mr. Hirsch has had a very wide experience in waterworks, water power and electric light projects.

PUBLIC WORKS.

CITY COUNTY STATE

A Combination of "MUNICIPAL JOURNAL" and "CONTRACTING"

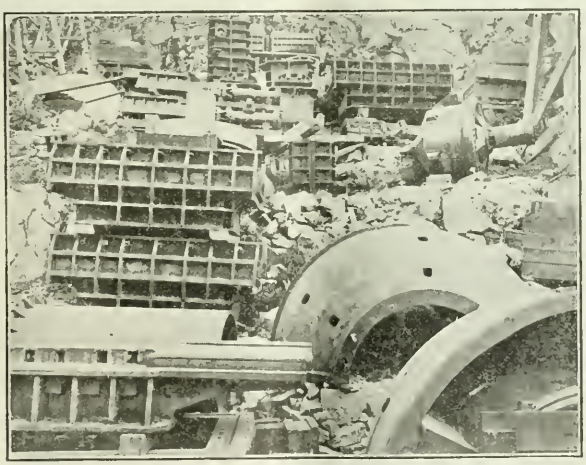
Vol. 53 July 8, 1922 No. 2

The Hetch Hetchy Dam

Concrete dam being built by San Francisco to impound 135,000,000,000 gallons of water. Ultimate height of dam from foundation to crest 430 feet, depth below bed of stream 117.5 feet, width of base 298 feet, final length 900 feet. The dam is now being constructed to a height of 226 feet above stream level with 375,000 yards of concrete, to be increased to 625,000 yards when dam is completed. River diverted through 900 feet of 23x35-foot rock tunnel by crib dam 40 feet high and about 320 feet long.

One of the principal features of the construction of the new Hetch Hetchy water works, which is being developed to supply 400,000,000 gallons of water daily to the San Francisco metropolitan area and develop 200,000 hydroelectric horsepower, is the Hetch Hetchy dam which when completed will have a maximum height of 429.5 feet from lowest point of foundation to crest, a length of 900 feet at the crest and a width of 298 feet at the base. It will contain 625,000 yards of concrete masonry and will impound 135,000,000,000 gallons of water in a reservoir having an area of 3 square miles, a length of 8 miles, a width of 0.7 miles, a maximum depth of 300 feet and average depth of 179 feet.

The dam, of the curved gravity type, has a radius of 700 feet at the crest and is composed chiefly of 1:3:6 cyclopean concrete, proportioned for ordinary normal pressures of 25 tons per square foot when the reservoir is empty and 15 tons per square foot when the reservoir is full and for a maximum temporary pressure, under the worst combination of conditions, of 27.5 tons per square foot. No tensile stress is permitted in the concrete. An upward pressure due to two-thirds of the total hydrostatic head is provided for at the upstream face diminishing to zero at the down stream face, where, however, upward pressure from backwater is considered. There is a system of drainage wells lined with 15-inch porous concrete blocks. The drainage wells are 100 feet apart parallel to the upstream face and



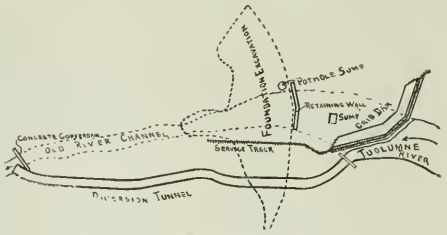
OUTLET VALVES AT SITE AWAITING INSTALLATION.

are bisected by radial contraction joints sealed by bent copper water stops.

At one end of the ultimate dam there will be a weir-type spillway and a waste-water channel. There will be six outlet conduits, 5 feet in diameter, located at three different levels for irrigation water, and six outlet conduits, 3 feet in diameter, for city water supply.

The flow into each conduit will be regulated by balanced needle valves of the Larner-Johnson type, and each outlet will have an hydraulically operated slide gate protected by a reinforced concrete shutter that may be lowered on the upstream side to close the conduit and permit entrance for inspection or repairs.

The dam will not be carried to its complete height at first, but the part now being built will be a complete dam and serve to impound water until the second section is built. The first section will include, in one continuous mass integral with itself, the foundation for the second section complete up to the original bed of the river, 117.5 feet above the lowest part of the excavation. The crest of this section will be 226.5 feet above the bed of the stream

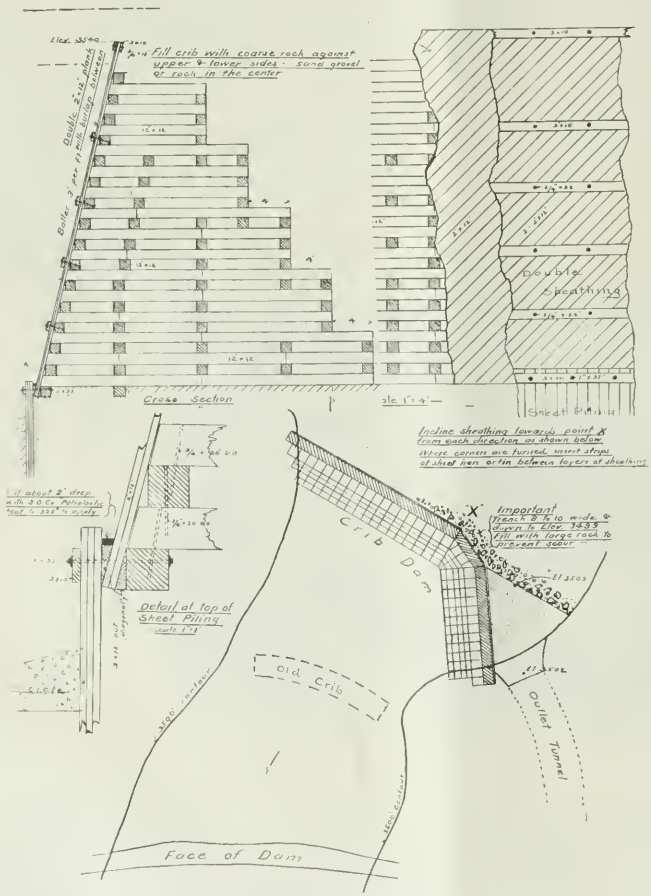


LOCATION OF DAM AND DIVERSION WORKS

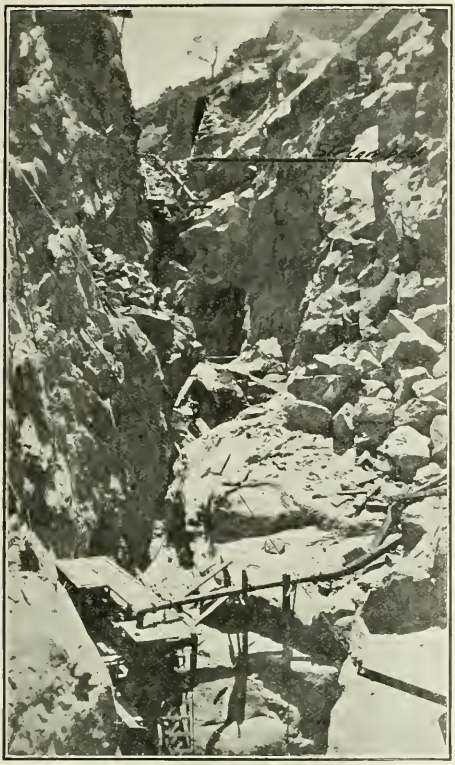
and will be 15 feet wide and 600 feet long. It will contain 375,000 yards of masonry and will have a siphon-type spillway constructed in 18 sections, having a total length of clear opening of 180 feet 6 inches and a height of 8 feet at the entrance tapering to 4 feet at the top of the siphon, and each section will be provided with two 12x24-inch air vents. (See page 24.)

The contract for the first section of the dam was awarded August 1, 1919, to the Utah Construction Co. at an estimated price of $5,447,792, and it is expected that the work will be completed in February, 1923. A general description of the dam was published in PUBLIC WORKS March 27, 1920, and papers on it have been presented by Mr. O'Shaugnessy, city engineer of San Francisco, to the American Water Works Association and to the American Society of Civil Engineers. From the latter, published on page 148 of Part 2 of Volume 48 of the Proceedings, some of the data for this description have been derived and the general cross-section of the dam has been reproduced.

The dam is built across the valley of the Tuolumne river in a canyon of the Sierra Nevada Mountains, more than 150 miles from San Francisco. It spans the whole width of the canyon with abutments and foundations on the solid granite rock. A short distance from the dam site the contractor built a temporary dam, convex upstream, across the bed


Fill crib with coarse rock against upper & lower sides; sand gravel or rock in the center
Double Sheathing
Cross Section
Incline sheathing towards point X from each direction as shown below. Where corners are turned, insert strips of shiplap between layers of shiplap
Important! Trench 2' to 10' wide, down to Elev. 3433. Fill with large rock to prevent scour
Crib Dam
Old Crib
Outlet Tunnel
Face of Dam
Detail at top of Sheet Piling

LOCATION AND DETAILS OF UP-STREAM DIVERSION DAM.



EXCAVATION 60 FEET BELOW STREAMBED; SO NARROW THAT STEAM SHOVEL WAS REMOVED.

of the river and diverted the stream flow through a rock tunnel 25 feet wide, 23 feet high and 900 feet long, with its outlet just below a concrete cofferdam, 51 feet long, built across the river chanel below the toe of the permanent dam, and having a grouted foundation on boulders and course gravel. The maximum measured flow of the river is 4,700 second feet and the tunnel was proportioned to carry this volume of water under a head of 13 feet above the top of the tunnel. After the completion of the dam, three of the 3½-foot conduits will be installed in it.

The diversion dam has a cut-off wall of Wakefield sheet piling driven 8 feet to a more impervious stratum and surmounted by rock-filled timber cribs 40 feet high, faced on the upstream side with a double layer of 3-inch planks with burlap and tar paper between and caulked on the outer surface. The joint between the crib face and the cut-off wall was asphalted. The down-stream side of the dam was rip-rapped to prevent sloughing and earth was deposited on the upstream side to give tightness.

After the foundation excavation of the permanent dam had been carried 63 feet below the foundation of the diversion dam, the earth on the downstream side of the latter was retained by a concrete wall, 30 feet high, and more than 100 feet away, convex upstream, which was securely anchored at both ends and prevented any serious movement of the bank adjacent to it, although considerable water from it flowed under the retaining wall.

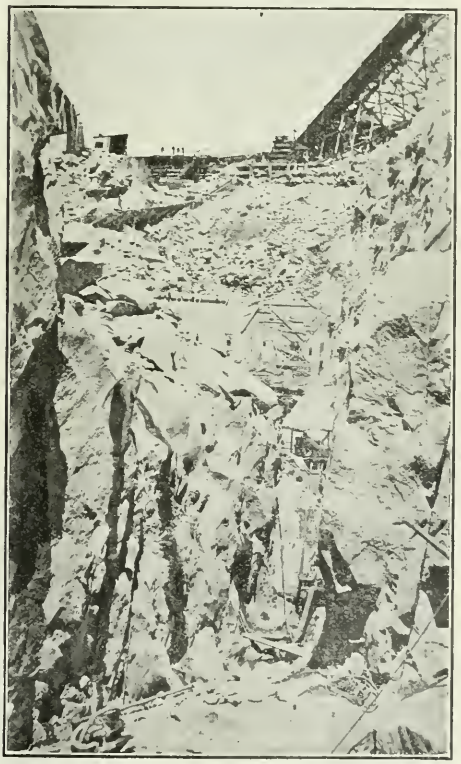
Water penetrating through and under the diversion dam was collected in a high-level sump and in a large natural pothole which served as a low level sump near the end of the retaining wall, from which the water from the lower elevations was pumped and discharged to the river bed 90 feet above. At all times the water in the beds was easily handled by centrifugal pumps from 6 to 14 inches in diameter.

A further description of the construction will be given in the next issue.

The dam was designed and is being constructed under the direction of M. M. O'Shaugnessy, city engineer. The resident engineer for the city is B. R. Rankin and A. Paddock is the construction engineer for the contractor who is represented by H. J. Lawler.

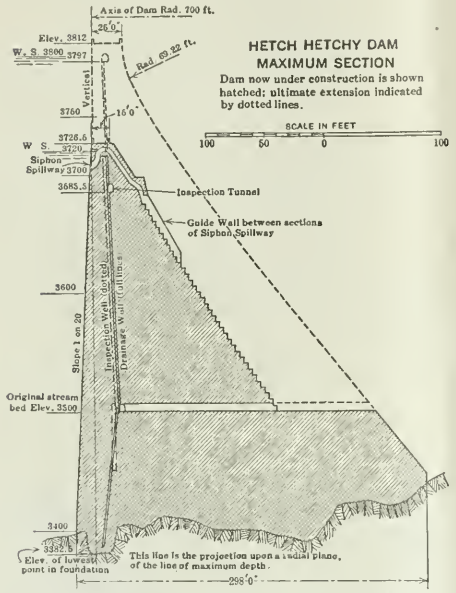
Repairing French Highways Necessary

A program of road building on a large scale in France is outlined in the new budget of the French Minister of Public Works, according to which much



DOWN-STREAM FACE OF DIVERSION DAM, AT TOP. RETAINING WALL WITH FORMS INJURED BY BLAST, SHOWN IN CENTER OF PICTURE. SUMP AND PUMPS IN FOREGROUND.

repair work is needed on the old system of French roads, which totals about 28,000 miles.



SECTION OF DAM, PRESENT AND ULTIMATE

Increased strain on the French highways has been caused by a larger use of motor traction. Figures received by the Bankers Trust Company, of New York, from its French Information Service disclose that the number of automobile tractors and lorries in operation increased from 8,000 in 1913 to 93,000 in 1921, and the total number of motor vehicles from 100,000 to 208,000. An increase in the average speed of operation has subjected the highways to an additional strain.

Construction Operation Increasing

The May Bulletin of the United States Geological Survey reports that the production of Portland cement in the United States during the month of May, 1922 exceeds all previous monthly records, and reached 11,176,000 barrels as against 9,287,000 barrels in 1921. The corresponding shipments were still larger, amounting to 12,749,000 and 9,488,000 for the same years. Similarly the total production for the first five months of the year amounted to 357,763,000, which was larger than for the corresponding months of any previous year. The great demand for Portland cement is attributed to the building boom now under way, to increase in municipal improvements and to the construction of concrete pavements.

As Portland cement is an important element in almost every item of engineering construction, the great and increasing amount now used may be taken as a reliable index of the magnitude and growth of activity in general construction.

Concreting Troy-Pocahontas Highway

Pavement 16½ miles long concreted by 32 men at the rate of 737 feet per day from central mixing plant, with special equipment for storing, measuring, and delivering aggregate, handling cement, charging mixer, loading and turning trucks

The 16 1/2-mile Federal Aid Project No. 9 road contract on the National Old Trail Highway between Troy and Pocahontas in Madison and Bond counties, Ill., was executed last season by the Hug Lumber and Construction Co., which secured notable rapidity and economy by the combination of special methods and improved equipment and arrangement for a central mixing plant service that eliminated much manual labor and promoted continuity and simplicity of operations.

The Illinois State Division of Highways directed the work, S. F. Wilson was assistant engineer in general charge of construction. J. L. Gary was resident engineer.

The pavement, 16 and 18 feet wide, was made with 1:2:3½ concrete 7 inches thick at the edges and 8 inches thick at the center. It was laid at an average rate of more than 500 and a maximum rate of 737 linear feet per day by a total force of 32 men using standard equipment supplemented by labor-saving devices invented by C. J. Hug.

RECEIVING AND STORING

The plant was established 1½ miles north of the Pennsylvania Railroad siding at Pierron, Illinois, and from this siding the materials were delivered by trucks equipped with pneumatic tires to parallel sand and stone piles, with a board fence between to separate sand from stone. The storage piles were about 200 feet long and about 20 feet from the mixer at the nearest end.

A wide track was laid between the stock piles extending to the mixer, and on it were installed two loading bins and a locomotive crane equipped with a 3/4-yard clamshell bucket which transferred the aggregate from the stock piles to the bins. These bins, mounted on six wheels, were placed ahead of the crane, and as the supplies of sand and stone diminished at one place both the crane and bins were moved forward.

MEASURING AGGREGATE

A special hopper under the bins measured the required amounts of sand and stone for a four-bag

PART OF CENTRAL MIXING PLANT

batch. This hopper was supported on a hanging runway under the bins which had two sets of discharge gates. When one set became clogged, the measuring hopper was moved on the runway to the other set of gates. The hopper was filled through slide gates under the bin, allowing materials to pile up under them in cone-shaped mounds until high enough to prevent any additional flow, this insuring that the proper amounts of sand and stone had been discharged, and the gate was then closed and the batch dumped into a special skip, which conveyed it to the mixer.

DELIVERING AGGREGATE

The skip was the regular mixer skip, removed and placed on six wheels. Four of these wheels traveled on a narrow gauge track placed between the rails of the wide guage track, and extending from the mixer under the bins to the top of a short incline terminating at the mixer intake. The other two wheels, at the rear end of the skip, had a wider gauge and when the skip neared the mixer they were carried on their track to a point 4 or 5 feet above the end of the narrow gauge incline, thus elevating the rear end of the skip and tilting it to discharge its contents into the mixer drum. As the skip traveled up the incline at the mixer it tripped two levers; the first released the water for mixing the batch and the second closed the mixer at the discharge end.

This arrangement allowed the mixer operator to concentrate his attention on handling the skip, which was pulled from the storage bins by means of a cable operated by a drum on the mixer engine. The drum was constructed for two speeds, the higher speed used while the skip traveled on level track and the slow speed used to hoist and tip the skip at the mixer. When the friction clutch was released, the skip dropped down the incline, gathering enough momentum to carry it automatically back under the bins. As the skip traveled past a platform at the side of the track, cement was added to the batch. In the rear of a loading platform parallel to the tracks was a cement storage house with a capacity of 35,000 bags.

Cement was trucked by hand from the warehouse to the platform and there dumped into a tilting box at the end of the platform. The box had an opening in the track side and was balanced on hinges. It was charged with four bags of cement while the skip was receiving the sand and stone under the bins. As the skip reached the cement platform it was stopped for a moment and the contents of the box were dumped on top of the batch of aggregate.

TRANSPORTING CONCRETE

The concrete was discharged from the drum of the Foote mixer into a batch hopper which was then raised on guides and dumped into the bodies of one-ton and two-ton speed trucks, equipped with pneumatic tires and special dump bodies. The two-ton trucks were designed and constructed by Mr. Hug and have established remarkable records under working conditions due to their economy of time and money. Each truck was numbered and the mixer fireman kept a record of the number of trips made by each. The trucks were turned on the subgrade by a turntable which was invented by Mr. Hug. It is operated by the truck's own power in a few seconds and is easily moved along the subgrade.

The average time per trip made by one-ton truck, 11 minutes; average time per trip made by two-ton Hug Speed truck, 7 minutes; average trips per 10 hours by one-tone truck, 40; average trips per 10 hours by two-ton Hug speed truck, 56. The trips were one mile each.

FINISHING SUBGRADE AND CONCRETE SURFACE

The concrete was tamped and finished with a Lakewood finisher. The subgrade was finished by

HAULING MIXED CONCRETE FROM CENTRAL MIXING PLANT IN ONE-TON AND TWO-TON TRUCKS WITH DUMP BODIES

a subgrading machine invented by Mr. Hug, the special feature of which is the facility with which it can be moved from one location to another, making it an easy matter to get off the subgrade. A special crank axle and wheel attachment straddles the machine and a lever attached to the axle makes it possible to lift and lower the wheels on the machine.

WORKING FORCE

The number of men required to operate the plant and to place and finish the concrete was reduced to a minimum, the distribution being as follows: one foreman, one clamshell engineer who also fired, one man measuring batches, two men dumping cement, two men wheeling cement from warehouses, one mixer operator, one mixer fireman, one auto mechanic, ten truck drivers, one man on turntable, three men spreading concrete, one finishing machine operator, two men setting forms, one roller engineer who also operated subgrader, one laborer on subgrade, one pump operator and two laborers covering and curing pavement.

The principal items of equipment installed for the execution of the work included an Orton & Steinbrenner Co.'s locomotive crane; special aggregate storage bins, hoppers and discharge gates; a subgrading machine and a turntable made by the Hug Co.; a 4-sack Foote concrete mixer and engine; a Lakewood concrete tamper and finisher; dump bodies made by the Lee Trailer and Body Co.; and automobile trucks made by the Hug Co. and by the Ford Motor Co.

Restoration of Bigelow Boulevard, Pittsburgh

Retaining walls and cribs and drains constructed to prevent recurrence of slip of 1920 have proved successful.

Bigelow Boulevard, named after the former Director of Public Works of Pittsburgh, is a principal thoroughfare for automobile traffic from the eastern residential suburbs into the business part of the city. It was built in 1898, and affords a beautiful well-paved driveway 40 feet wide, exclusive of gutters and sidewalks, which approximately follows the contours of the hillside along the winding shore of the Allegheny river at an elevation of 74 to 290 feet above the water and the manufacturing plants and railroads in the river valley.

SUBSURFACE DRAINS IN FILL

SLAG FILL AND WOOD CRIB

For a distance of about 1,500 feet it was constructed largely in terraces excavated in the steep hillside or composed of a high fill chiefly consisting of rock and soil from city excavations. The geological formation of the hillside was largely shale and sandstone sparsely covered with loose earth, grass and small trees and shrubs that afforded opportunity for penetration of rain and the collection of water in the seams and crevices between rock strata near the surface. Conditions were such that soon after the completion of the boulevard, cracks and settlements began to appear and were followed by slips and landslides, some of them requiring extensive repairs.

An important slip occurring in November, 1920, displaced an estimated amount of 125,000 yards of earth and rock and wrecked about 300 feet of the boulevard, making it necessary to undertake extensive repairs which were accomplished by a force of about 100 men in four months and cost about $135,000. This involved about 1,000 yards of excavation, 22,000 yards of slag fill, and 2,200 square yards of new paving to restore the original width and surface of the boulevard.

In order to prevent recurrence of the difficulty at this and adjacent points extensive precautions were taken by building retaining structures at the foot of the slope and by constructing a thorough system of drainage intended to prevent the collection of water under the surface and avoid the development of slippery strata and planes of separation on the inclined surfaces of the rock strata.

Near one of the worst points of the slip a 10x30-foot sump was sheeted down to a depth of 14 feet and was provided with natural drainage through two 20-inch cast-iron pipes about 20 feet long, extending from the bottom of the sump, under the foot of the slope, to a point whence they could freely drain into the railroad drain. These pipes have carried an estimated maximum flow of about 14,500 gallons per day, and since their installation no farther indications of settlements have been observed in the embankment above.

In many places on the face of the embankment longitudinal trenches have been dug and tile pipe drains embedded in a mass of broken stone have been installed in them to intercept water flowing down the incline and discharge it to various sumps

and outlets which are expected to be efficient in maintaining dryness and stability in the slag rock, and earth fill as well as in the natural earth slope. About 4,500 feet of vitrified pipe from 4 to 15 inches in diameter and 1,200 yards of broken stone were used for this purpose.

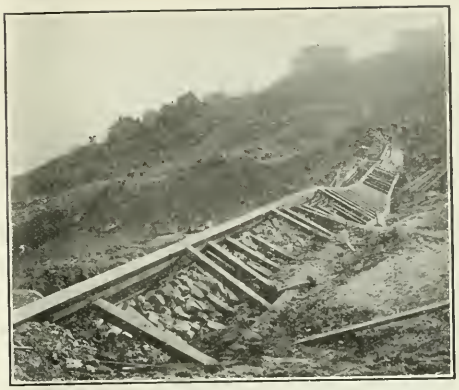
The foot of the slope has been retained by about 330 lineal feet of rock-fill timber cribs in an inclined plane forming a revetment to the surface of the embankment. These cribs having a maximum height of about 12 feet on the incline, are from 6 to 8 feet in width, and are made with two solid walls of 12x12-inch longitudinal timbers braced by well-bolted timber cross-ties from 6 to 8 feet apart in every course, and finished with a solid continuous upper course of transverse timbers, below which the cribs are filled with broken stone providing heavy weight for stability and abundant openings for drainage.

The cribs contain about 23,500 feet of untreated timber which is expected to last for several years until the embankment above them becomes so thoroughly solidified as to be permanently stable without future retaining. It is estimated that the cribs are as efficient as rubble masonry or concrete, and cost less than half as much as the latter would. They were designed and constructed under the direction of Norman Brown, director of the Department of Public Works, and C. M. Reppert, chief engineer; Assistant Chief Engineer Reed was in immediate charge of the construction work. Special Construction Engineer A. L. Snyder was the engineer located on this work and was in charge of same.

$24,000,000,000 For County Highways

An article by Henry E. Shirley, engineer of the Road and Sewerage Department, Baltimore County, Maryland, published in the May *Constructor*, contains interesting data on the 2,400,000 miles of highways in the 3,100 counties in the United States. About one-fifth of this mileage is under state control and the remainder is under county and township control. In the South, Central and Western sections the county is the unit of operation for all local administrative and often for construction activities outside of towns and cities.

DETAILS OF WOOD CRIB RETAINING SLAG FILL.



TOP OF FILLED CRIB AT TOE OF SLOPE.

Highway traffic has increased from 1,000 to 1,500 per cent. in the last few years and highway construction expenditures are from $150,000,000 to $200,000,000 per year for State highways and about the same for county highways. The author estimates that within 25 years the states will take over and construct from 20 to 25 per cent. of the mileage of the county, leaving the counties to construct about 400,000 miles of high grade roads at a cost of $10,000,000,000, an additional 400,000 miles of secondary roads at a cost of $8,000,000,000 and 1,000,000 miles of unimproved earth roads to be improved at a cost of $6,000,000,000, making a total cost of $24,000,000,000 or more than one billion dollars per year necessary to put the county and township roads in condition.

Engineers' Plans for State Health Boards*

Regulations of the State Boards of New York, North Carolina, North Dakota and Ohio.

The engineer's report shall deal with quantity and quality of supply; present and future consumption; location, capacity, etc., of reservoir or tank; character and area of watershed; present and future contamination and control of same; controlling, diverting or regulating works; maximum, minimum and average static pressures in the territory to be served; number of fire streams allowed for, pressure available during fires and length of time they can be maintained; number and distribution of fire hydrants; purification works; "and any other material facts."

The estimate of annual cost must show estimated total annual cost of operating the works, including interest payment, sinking fund or bond principal payments, supervision, maintenance, operation, repairs and extensions. A schedule must show the

*Continued from page 7.

method proposed for raising the funds to meet these payments, including estimated receipts from water rates, fire protection, direct taxation or otherwise. There must be a statement of the total assessed valuation of municipality, tax rate, and effect of operation of proposed works on same.

Specifications of the proposed works shall be filed, whether or not they are to be built by contract.

Bacteriological and chemical analyses of representative samples of the water proposed to be used, made by the State Department of Health or by a competent analyst, shall be furnished, accompanied by affidavit of a responsible representative of the petitioner that the samples were taken from this supply and stating specifically where, when and under what conditions.

The letter of transmission must state the most suitable place available for a public hearing, names and days of publication of all local newspapers suitble for publication of notice of hearing, and names and addresses of petitioner and petitioner's counsel and engineer.

New York. *Sewerage.* All sewerage plans must be submitted to and approved by the state engineer, and permits must be secured from the state commissioner of health for the discharge of sewage and sewage effluents into the waters of the state.

Applications must be accompanied by plans, specifications and a report describing the system in detail. The plans must be in triplicate and the two sets intended for filing with the state must be on tracing cloth, plain cloth or print cloth. One set will be returned with either the approval or disapproval of the state engineer.

General plans must be on a scale not smaller than 300 feet to an inch and preferably not larger than 100 feet to an inch. These will show boundaries, streets, water courses and other topographical features, contour lines at not less than 5 nor more than 10-foot intervals and surface elevations at street intersections; also existing sanitary and combined sewers, but not necessarily storm sewers. There must be shown all the sewers in a complete design of the system, indicating the material, grade, elevation of invert at changes of grade, direction of flow; location of all appurtenances, pumping stations, disposal works, sewer outlets; elevation of stream bed and of high and low water in the stream. The lettering and figures must be of appropriate size and of distinct outline. Surface elevations should preferably be just outside the street line and those of sewer inverts close to the manhole or other appurtenance; both given to the nearest tenth of a foot. All appurtenances must be shown by suitable symbols. Sizes, gradients and direction of flow should be shown between all consecutive manholes or flush tanks. All structures must be indicated by symbols and not by colors, the entire map being drawn in black.

Profiles must be submitted of all sewers more than ten inches in diameter, and all smaller ones when used as main intercepting or outfall sewers. The horizontal scale must be at least as large as that of the corresponding plans and the vertical scale not smaller than ten feet to an inch. Figures must be given showing sizes and gradients of sewers, surface and sewer invert elevations. Stream crossings and sewer outlets with elevations of stream bed and average high and low water must be shown.

There must be detail plans of sewer sections other than vitrified or cast iron pipe, of all ordinary sewer appurtenances and of any special appurtenances or structures such as regulators, pumping stations, etc. These must be drawn to such a scale as to show suitably and clearly the nature of the design, with sufficient dimensions and explanatory notes to make them readily intelligible for examination and a guide for construction.

Where sewage disposal works are planned, complete detail plans must be submitted showing the type and arrangement of all appurtenances such as screens, siphons, sprinkling filter nozzles, etc.; but detail plans need be furnished only of the portions it is intended to construct at present, but provision must be made for future completion of the works, and the location and general arrangement of the complete works must be shown.

Specifications must be submitted together with an estimate of the cost. An engineer's report must be submitted giving full information concerning the design, including the extent of area to be sewered at present and in the future, present and future population, per capita rates or volume of sewage, general character of sewage and proportion and nature of factory wastes, full statement of any known use for potable purposes of the stream into which it is proposed to discharge the sewage or effluent, and the drainage area above points of discharge and recorded or estimated maximum, average and minimum flows. There should be a brief description of the water supply of the municipality, a description of all conditions peculiar to the locality and affecting the design in any way, a description of all special devices used in the design and of any special points to be observed in the maintenance and operation of the system, and a full description of the general arrangement and special features of the proposed sewage disposal works, reasons for the choice of the method proposed and description of its operation.

Accompanying these regulations is a statement of the general requirements of the board, such as that all outfall sewers must be carried below low water, that bypasses around sewage disposal works will not be permitted, that sewer gradients should be sufficient to produce a velocity of not less than two feet when flowing full or half full, that manholes should not be more than 300 to 400 feet apart, that only the separate system will be approved except in certain restricted districts and for very cogent reasons, and that all rain water from roofs and streets and all avoidable leakage must be excluded. In general, rates of operation of sewage treatment plants must not exceed 100,000 gallons per acre per day for intermittent sand filters, 100,000 gallons per acre per day per foot of depth for contact beds, and 300,000 gallons per acre per day per foot of depth for sprinkling filters; and the effective depths of sand filters must generally be between 3 and 5 feet, of contact beds between 4 and 7 feet, and of sprinkling filters between 5 and 9 feet.

The above regulations are for municipal systems. For institution and private systems and for the disposal of industrial wastes the regulations differ somewhat.

North Carolina. This state is about to issue a bulletin giving complete requirements as to submission of plans for water and sewerage systems. The State Board of Health requires a complete engineer's report on every project, outlining in detail all information necessary to form an intelligent opinion. There is also required a general map of the watershed and source of supply and detail plans of all features of the system. Maps and drawings should be 42 inches in length and 36 inches in width and the scale should be such as to bring out clearly all the information intended to be shown.

North Dakota. Plans, specifications and engineer's report must be submitted in triplicate. The regulations for North Dakota are the same as those already published for the state of Arkansas except for the following minor exceptions. Under the head of "Water Works," drawings may be "printed on transparent cloth or on any of the various papers which give distinct lines." The items of "Source of Supply" and "Map of Watershed," required in the engineer's report by Arkansas, are not mentioned in the North Dakota regulations. Also the requirement that the estimate shall include quantities with unit prices used for the different parts of the work is omitted.

Under the head of "Sewerage Systems," contour lines on the sewer map are not called for nor the location of disposal works. In the case of the profiles, the horizontal scale of 100 feet to 1 inch is suggested, while a plan showing the location of Y connections, etc., under each profile is not called for. Under the head of "Disposal Works," plans for disinfecting plant are not included as always necessary. The same difference in making of plans and submitting of estimates is found as in the case of "Water Supply." The forbidding of bypasses is not included in the North Dakota regulations.

Ohio. The chief engineer of the State Department of Health, W. H. Dittoe, writes: "This department does not specify sizes and scales of maps, plans and drawings and these matters are left to the designing engineers. In very rare instances, unsuitable sized and scaled drawings are submitted and in such cases redrawing of the plans is necessary. However, in such instances it is usually the case that the plans are entirely unsatisfactory apart from the size and scale and redrawing would be necessary in any event.

"As a general proposition, this deparment looks with disfavor upon the publication of definite requirements as to design and preparation of plans. Instead, we encourage the utmost co-operation and interchange of views between the engineer and this department in connection with any particular project. Naturally this department must be guided by standards of design resulting from general experience and in accord with good engineering practice, but we do not think it is necessary to publish such standards and in many instances we feel it would be distinctly undesirable."

The regulations require that plans be submitted to the State Department of Health in duplicate, and be accompanied by specifications in duplicate, and a report prepared by the designing engineer giving data regarding the project and evidence of approval of the plans by the council or other governing body of the municipality. (The last requirement may be waived if the improvement is to be made by a firm or corporation.) The plans and specifications must give sufficient detailed information to permit a clear understanding and intelligent review of the project. The plans for a water supply should include a location map showing topography, water courses, roadways, and cesspools, dumping grounds and other possible sources of contamination within 1,000 feet of a proposed underground source of supply; also detailed drawings showing clearly the methods of pumping, purifying, storing and distributing the supply and protecting it from contamination. The sewer map should show the topography, location, size, lengths, grades, manholes, and other accessories of the proposed sewers; profiles should be prepared; also detail drawings of sewer sections, manholes and other appurtenances, pumping stations, etc.; there should be a topographical map of the site proposed for sewage treatment plant and detail plans of such plant.

The health board has prepared a number of printed forms of several pages each, to be filled in with "Information Regarding Proosed Water Purification," "Information Regarding Proposed Surface Water Supplies," "Information Regarding Proposed Ground-Water Supplies," "Data Regarding Proposed Intercepting Sewer," "Data Regarding Proposed Sanitary Sewerage," "Data Regarding Proposed Combined Sewerage," "Data Regarding Proposed Storm Sewerage," and "Data Regarding Proposed Sewage Treatment Plant." These questions are given in considerable detail and the answers to them really constitute a quite complete report on the subject. For example, the form for recording data regarding proposed sewage treatment plant contains about 200 questions, some of which can be answered by a brief yes or no while others require considerable space for reply, such as the estimated cost of the plant, complete description of method of dewatering sludge, etc.

40,000 Gallon Steel Tank Moved on Flat Cars

A steel locomotive water supply tank of 40,000 gallons capacity, with a conical bottom terminating in a large diameter riser pipe and supported on four steel columns about 20 feet high, was recently jacked up 20 inches and transferred to temporary support on timber falsework, installed on the adjacent ends of two standard gauge flat cars, heavily ballasted on the opposite ends, that were brought up on spur tracks close to the water tower on opposite sides. The cars were coupled together by chains and the top-heavy empty tank was ballasted by several yards of gravel deposited on a temporary floor at the bottom of the riser pipe which cleared the rail.

The falsework tower was blocked and wedged to bearing on the inclined bottom of the tank, and the tops of the steel columns were guyed with tackles to the flat cars.

The tank was hauled two miles over the Canadian National Railway to Redpath Junction, British Columbia, without injury, care being taken to adjust the position of the cars when passing around curves by means of turnbuckles connecting the chains.

Meters Require Maintenance

Walter Griffin, superintendent of the Bayonne, N. J., water department, stated recently that the department has increased its revenue about $230,000 without increasing the quantity supplied, largely through putting its meters in order. When he first came to the department he found that many of the meters were under-registering, about 700 houses paying less than 50 cents a year for water because the meters had been allowed to get into such condition as practically to fail to register. These meters have now been replaced with new ones and the result has been a most material gain in the revenues of the department.

Fourth Bates Road Test

Result of two thousand day and one thousand night applications of trucks loaded with 5,500 pounds on each rear wheel.

The fourth of the runs or increments of the progressively increasing loads applied to the Bates road, the test road of the Illinois Division of Highways, was run on June 5th to 14th. In this the load was 5,500 pounds on each rear wheel and 1,900 pounds on each front wheel, corresponding to 550 pounds per inch of nominal width of rear tire and 380 pounds per inch of front tire.

Three thousand applications of the load were made, 1,000 in the daytime, then 1,000 at night, and finally another 1,000 by daytime. The trucks ran in the same tracks as during the third run. As stated last week, the first five sections had been completely destroyed during the third run and were omitted from the fourth.

Under the fourth increment 38 decisive failures resulted, 22 occurring in the daytime and 16 at night. Only 4 of the failures occurred in the north side, the remaining 34 developing on the south side where the line of traffic was directly on the edge of the pavement. The highway officials believe that "these figures prove the contention that if the line of traffic can be held away from the edge of pavements, less failures would occur than when the wheels of the trucks pass directly on the edge." As the number of night applications was just half of the daytime, the number of night failures was 50% greater than the day failures in proportion to the number of applications.

Of the asphaltic concrete pavements on macadam base, one failed completely under the fourth increment. Of the six sections of this type of pavement, one had already failed completely under the first increment, two under the second and one under the third. After 2,400 applications of the fourth increment, water was applied to the subgrade under this section by pouring 500 gallons into short trenches at two points along the south edge of the pavement, following which a failure occurred which was believed to be critical. This was done because the subgrade had dried out somewhat and it was desired to learn the behavior of this pavement under the most adverse conditions. Similar treatment was given another section, as described later on.

Of 12 sections of asphaltic concrete on portland cement concrete base, 6 showed no additional failures under the fourth increment and 6 showed one corner failure each, 5 of which were classed as decisive breaks and the sixth as not decisive.

Of the 13 sections of bituminous filled brick on portland cement concrete base, 9 of them showed no additional failures under the fourth increment, 3 showed one additional corner failure each, 2 of which were considered to have reached their carrying capacity under the second increment and one under the third increment; while the 13th section showed progressive failures on both sides of previously broken adjacent corners, this section also having been considered a failure under the second increment.

Of the seven monolithic and semi-monolithic brick pavements, one was considered to have failed decisively under the first increment, two under the second increment and one under the third increment, the last showing four additional corner failures and progressive breaking at three points under the fourth increment. The other three sections showed additional corner failures under the fourth increment.

Of the 27 portland cement concrete pavements, 3 were considered to have failed decisively under the second increment, 5 under the third increment and 1 under the fourth increment, 13 showed no apparent failures under the fourth increment, and the others all showed two or three additional corner failures or cracks under this increment.

Section 58, which consisted of 4 inches of concrete on a 4-inch rolled stone base, withstood the first three increments without any apparent failures, which was entirely unlooked for as all the other 4-inch concrete sections showed failures to some degree. It was thought that the explanation of this was that the subgrade under this section had dried out more than elsewhere. Moisture sample tests under concrete pavements that had been laid directly on the subgrade showed a moisture content of the soil practically as high as during the spring months and consequently these sections are thought to be receiving the latest heaviest loads while in practically the same condition as when the light loads were applied. In order to determine what the action of Section 58 would be if under the same adverse condition, at the end of 1,750 applications of the fourth loading, a ditch was dug in the shoulder along the south edge of this section and filled with water. Holes were dug opposite this ditch along the north edge and the appearance of water in these holes within 45 minutes after it was placed in the ditch on the south side indicated that the subgrade had been thoroughly saturated. Nineteen Hundred gallons of water were placed in this ditch. Shortly after this, two decisive corner failures occurred in this section, with progressive breaking at one of them.

The fifth increment of load was such that each rear wheel of the trucks carried 6,500 pounds and each front wheel 1,800 pounds. The result of this will be described later.

PUBLIC WORKS.

Published Weekly
at 243 W. 39th St., New York, N. Y.

S. W. HUME, President J. T. MORRIS, Treasurer

Subscription Rates
United States and Possessions, Mexico and Cuba $3.00 year
All other countries..... 4.00 year
Change of Address
Subscribers are requested to notify us promptly of change of address, giving both old and new addresses.

Telephone (New York): Bryant 9591
Western Office: Monadnock Block, Chicago
A. PRESCOTT FOLWELL, Editor
FRANK W. SKINNER, Associate Editor

CONTENTS

THE HETCH HETCHY DAM. Illustrated..... 21
Repairing French Highway Necessary..... 23
Construction Operation Increasing..... 24
CONCRETING TROY-POCAHONTAS HIGHWAY. Illustrated 24
RESTORATION OF BIGELOW BOULEVARD, PITTSBURGH. Illustrated 26
$24,000,000,000 for County Highways..... 27
ENGINEERS' PLANS FOR STATE HEALTH BOARDS 27
40,000 Gallon Steel Tank Moved on Flat Cars..... 29
Meters Require Maintenance 30
FOURTH BATES ROAD TEST 30
EDITORIAL NOTES 31
Should Check Valves Be Used at Service Meters?—Skill in Rock Blasting.
Paving Stone in 1921 32
National Hydraulic Laboratory 32
Strenuous Flood Protection Work 32
John A. Bensel 32
RECENT LEGAL DECISIONS..... 33
USE OF METERS AND CHECK VALVES. Table. 34

Should Check Valves Be Used at Service Meters?

Recently we saw included in the rules of a water company a requirement that a check valve should be set with every meter, and as this seemed to us unusual we made inquries concerning the prevalence of this practice.

We found that of 691 companies and departments replying, 69 per cent did not use check values at meters at all, 9½ per cent used them in "some cases," "where necessary," etc., 4 per cent where steam boilers are connected, 3 per cent where meters had been damaged by hot water, 1½ per cent where hot water heaters are used, and from one to three reported use under each of the following conditions: with large meters, large heating plants, steam coils, hot water and range boilers, high pressure boilers, close to hot water line, factory boilers direct connected, in shops, laundries, hotels and large buildings, where hydraulic elevators are used. Four put it up to the consumer. "Yes" was replied by 8½ per cent, but whether this meant all meters or some was not definite.

It is evident that the great majority of those requiring the use of checks do so to prevent damage to the meters by hot water backing through them from the connected buildings. At the convention of the American Water Works Association instances were reported where these checks were believed to have been responsible for explosions in residence plumbing, and doubt was expressed by some as to the effectiveness of relief valves combined with the checks to prevent such accidents.

One member at this convention said he preferred to occasionally renew a meter disk rather than feel responsible for a single kitchen boiler explosion with its possible loss of life. Put in this way, we believe all superintendents would agree with him. If all regulations contained (as probably most of them do) a provision holding the consumer responsible for damage to meter from heat or freezing, this would seem to relieve the water company or department of expense from this cause; and if consumers are duly warned of the probable causes of such damage, preventive measures and precautions are up to them.

Other accompanying effects, such as heating of water in mains or running the meter backward at very infrequent intervals, would seem to be of minor consideration compared to the possibility of serious accidents.

Skill in Rock Blasting

Rock blasting is an operation influenced by so many local conditions that its success is generally largely dependent upon good judgment and extended experience in the particular locality where the work is executed.

The hardness of the rock, its homogeneity, stratification, dimensions, character of excavation, required dimensions of quarried stone, the equipment for drilling, quality and amount of explosives and rapidity of operations are among the important factors that determine the result in quarrying operations. It is comparatively easy to drill a few holes, load and fire them and shatter a considerable amount of rock that may vary hundreds of per cent. in the total amount of rock loosened per pound of explosive, which may be detached in large masses, shattered to small fragments, barely lifted or blown a long distance. The explosive may expend all of its energy on useful work or a large amount of it may be dissipated in useless or even injurious effects. To locate, direct, dimension and proportion the holes and adjust the powder so as to break the rock where and as required at the minimum final cost is something that must be determined by thorough knowledge of the known conditions, wise judgment of any that are unknown, and with a great deal of skill, experience and courage in the direction of a large job.

For a very large blast individual drill holes are generally replaced by shafts and tunnels containing considerable quantities of dynamite in bulk. Their arrangement to loosen a great yardage of rock and to break it into comparatively uniform fragments of a given size without endangering surrounding property or throwing it too far, is a delicate operation. A remarkably successful achievement of this sort was that reported from Havelock, Ontario, Canada, where about 200,000 tons of trap rock were recently lifted and shattered by the simultaneous explosion of 30 tons of dynamite without, it is claimed, throwing any portion of the rock more than 100 feet. Nearly all of the rock was broken sufficiently to enter a 48x60-inch crusher and was left in an accessible position involving a minimum cost of handling. The

material, corresponding to about 80,000 yards of rock displaced and probably twice as much after being crushed to commercial sizes, was enough to build about 80 miles of concrete road 18 feet wide.

It is estimated that a 10 per cent. larger charge of explosive would have lost most of the rock by throwing it into an adjacent swamp, and 10 per cent. less explosive would not have sufficed to shatter it.

The success of this work is comparable with that of a big blast under very different requirements that was made several years ago for the construction of the Otay Dam, where many thousand yards of rock in the face of the canyon were blown off by a single blast that hurled the rock into the bed of the stream in such a position that much of it sufficed without rehandling to form a portion of the embankment that gave stability to the gravity dam having a steel plate core wall embedded in a thin covering of concrete that extended through the heart of the dam and into recesses cut in the flanks of the mountains at both ends.

Paving Stone in 1921

Figures published by the U. S. Geological Survey for the year 1921 show that while building stone was in little demand and the output of monumental stone decreased more than 45 per cent., paving blocks were in great demand and increases were shown in the sales of curbing and flagging, indicating a revival in street work in cities and towns. There was also an increase of nearly 8 per cent. in the output of crushed stone, due largely to highway work.

The figures given show that in 1920 the sales of paving blocks amounted to 35,959,200 blocks valued at $2,898,459, while in 1921 48,000,000 blocks were sold at an estimated value of $3,000,000. (The 1921 figures are not complete, as the returns were not all in a few weeks ago when this estimate was made, but is believed to be approximately correct). The cubic feet of curbing increased from about 1,500,000 in 1920 to 2,000,000 in 1921 and the cubic feet of flagging from about 689,000 in 1920 to about 700,000 in 1921.

National Hydraulic Laboratory

At the suggestion of John R. Freeman, Senator Ransdell of Louisiana has introduced a bill providing for a national hydraulic laboratory to study flood control and river hydraulics, and the chairman of the Committee on Commerce will ask that a subcommittee be appointed to consider this bill. It is hoped that this will result in investigations that will give the scientific side of river hydraulics the services of research and experimentation equal to those that have been devoted to other branches of engineering.

Strenuous Flood Protection Work

A big hole in the Mississippi river levee in Tunica county, Mississippi, was considerably enlarged in 1916 and threatened the destruction of the levee in the flood of April 20, 1922. The condition was considered to be of great emergency, threatening $10,000,000 worth of property, and a large force was immediately employed making dikes, trestles and revetments and checking the erosion with brush, sacks of earth, steel piles and other resources. In ten days there were used in the "Devil's Hole" 100,000 sacks of earth, from 500 to 800 wagon loads of brush, 50 coils of ¾-inch and 250 coils of ¼-inch rope. Part of the time an emergency force of 800 men and a maximum of 70 wheel scrapers with snap and plow teams were employed. Incessant work was necessary to offset the tremendous erosion, which on one occasion caused a 20-foot subsidence of the revetment. The work was in direct charge of A. L. Dabney, consulting engineer, Memphis. It cost about $50,000 and was considered to have paid 10,000 per cent on the investment.

The Federal Power Commission has received an application from the municipal authorities of Louisville, Ky., for a preliminary permit to cover the power developments at the U. S. lock and dam in the Ohio river at the Falls of Louisville. The city proposes to install 50,000 horsepower when the dam is reconstructed.

The twentieth anniversary of the approval of the reclamation act was on June 17. The Service has constructed over 100 storage and diversion dams, 13,000 miles of canals, ditches, etc., 27 miles of tunnels, costing $133,000,000 and increasing the value of land about $500,000,00.

The Swing bill providing an expenditure of $70,000,000 at the Boulder Canyon and along the Colorado, has been sanctioned by Secretary Fall. Secretary Hoover has also appeared before the Committee. This measure will provide 166,900 acres for ex-soldiers and affects the entire stream system of Arizona, California, Colorado, New Mexico, Nevada, Utah, and Wyoming.

John A. Bensel

John Anderson Bensel, civil engineer, for many years prominent in New York City and New York State, died June 19th in his home in Bernardsville, New Jersey, after an illness of several months. He was a graduate of Stevens Institute of Technology, and was for some years a member of the firm of Spears and Bensel, who executed a considerable amount of substructure and construction work in New York City.

For several years he served in the Department of Docks, New York City, as chief engineer, from 1898 to 1905, and as Commissioner from 1906 to 1908. He was afterwards made a member of the Board of New York Water Supply and was also State Engineer for New York. During the war he was a Major in the Engineering Corps and at the time of his death was consulting engineer for the New York and New Jersey Vehicular Tunnel Commission. He was a member of several engineering clubs and societies and past president of the American Society of Civil Engineers. He is survived by a wife, two sons and two daughters.

Recent Legal Decisions

EFFECT OF FINAL CERTIFICATE UNDER HIGHWAY CONSTRUCTION CONTRACT

The certificate of a county engineer as to the quantity and value of excavation done by a highway contractor can be impeached for fraud, or for gross mistake amounting to fraud. And the California Court of Appeals holds, Vaughan v. Tulare County, 205 Pac. 21, that the finding of the trial court, in an action for balance due on a contract for highway construction, that nearly 25 per cent. of the yardage on a large contract was mistakingly omitted would support the conclusion that a "gross mistake" had been made.

The court also said that an express provision in the contract that the final certificate was "conclusive evidence of the performance of the contract" and "against any claim of the party of the first part," being the county, without any specification that it should be conclusive evidence of the amount due the contractor, or against any claim of his, made it probable that the final certificate was intended to be conclusive evidence, against the county, of the performance of the contract, and not against the contractor, of the amount due.

STATUTE AUTHORIZING EXTRA COMPENSATION TO HIGHWAY CONTRACTORS ON WAR CONTRACTS HELD UNCONSTITUTIONAL

The New York Court of Appeals holds, Gorden v. State, 233 N. Y. 1, 134 N. E. 698, that a highway contractor who had entered into a contract with the state after the commencement of the Great War, but before the United States had become a party, was bound to perform the contract for the consideration therein specified, notwithstanding the burden of increased cost of labor and materials because of war conditions. Chapter 459 of the New York Laws of 1919, authorizing the termination of highway contracts entered into before April 6, 1917, and conferring jurisdiction upon the Court of Claims to hear and determine claims and make awards for increased costs incurred in the completion of such contracts, is held invalid in its entirety, since its purpose and effect is to grant to contractors extra compensation within the prohibition of the state Constitution, art. 3, §28.

LANDOWNER CANNOT OBJECT TO STEPS TAKEN BY DRAINAGE DISTRICT AND CONTRACTOR RESULTING IN DELAY

A drainage contract by its terms fixed the time of its performance and provided for the payment of damages to the drainage district for each day of delay in the performance, and also provided under what circumstances an extension of time could be secured. It is held, Tant v. Little River Drainage Dist., 238 S. W. 848, that a landowner in the district had no right to object to any steps taken by the contractor and the district under these provisions of the contract resulting in delay. The district was the only party who could complain, in the absence of a showing of collusion between the district and the contractor, and that condition was not shown in this case.

METHOD OF ASCERTAINING VALUE OF WATERWORKS SYSTEM FOR ITS PURCHASE BY THE MUNICIPALITY

On the purchase of a waterworks' system by a city from the owners of the system, as between the city and the owners, the Supreme Court of Kansas holds, City of Baxter Springs, Bilger's Estate, 204 Pac. 678, that the service lines between the mains of the system and the property line of its consumers belong to the owners of the system, whether put in by such owners or by its consumers, where the franchise does not specify who shall pay the expense of putting in such service lines.

In an action to determine the value of a waterworks' system for purchase by the municipality, deductions from the amount ascertained by engineers to be the value may be made by the court, where it, after a consideration of all the evidence, finds that such deductions should be made. The court may in this way deduct from the total valuation placed upon the system by engineers the value of any part of the plant as fixed by the engineers, where the court finds from the evidence that that part has no value whatever. In such an action the amount to be deducted for "functional depreciation" is a matter that must be determined by the court from the evidence.

FINDING BY COUNTY COMMISSIONERS OF PUBLIC UTILITY ROAD IMPROVEMENT NECESSARY

The Kansas Supreme Court holds, Hermann v. Larkin, 204 Pac. 768, denying a writ of mandamus to compel a county to proceed with the improvement of a public road, that in order to authorize the improvement of a road under the Kansas statute, it is necessary for the county commission to make an absolute and unconditional finding of its public utility, and that a finding that it is of public utility upon a stated condition is not by the subsequent fulfilment of the condition rendered effective without further action by the board.

PROTECTION OF MATERIAL MEN BY PUBLIC WORKS CONTRACTORS' BONDS

The Arkansas Supreme Court, in Oliver Construction Co. v. Williams, 238 S. W. 615, citing Hill v. American Surety Co., 200 U. S. 197, (construing the statute requiring bonds from contractors with the United States for public works) holds that such statutes and contracts should receive a liberal interpretation to attain the benefit intended, and the requirement of the Arkansas statute that a contractor on public works shall give a bond for payment of all indebtedness for labor and materials furnished is broad enough to include laborers who have performed work for a subcontractor who furnished labor or materials which the original contractor was under obligation to furnish under a contract with a road improvement district. The giving of the bond under the statute adds nothing to the obligation of the contractor. It only has the effect of adding sureties to his obligation and thus more effectively protecting those furnishing labor and materials which are used in the public improvement.

USE OF METERS AND CHECK VALVES

Continuation, from the May 13th issue, of tables prepared from data furnished by superintendents of nearly eight hundred cities.

Municipality	Can their use be legally required?	Are check valves used at meters?	Have check valves damaged kitchen boilers or house piping?	Size of meters for ordinary residences
Arizona:				
Clifton	yes	no	no	5/8" and 1/2"
Douglas	yes	no	.....	5/8"
Glendale	if customer requests	when connected to boiler	no	5/8" and 3/4"
Nogales	yes	very few	yes	5/8"
Prescott	yes	no	.....	5/8"
Tucson	....	no	.....	5/8"
Arkansas:				
Helena	no	where necessary	no	5/8"
Russellville	yes	no	.....	5/8"
California:				
Anaheim	yes	no	.....	5/8"
Benicia	yes	no	.....	5/8"
Burbank	yes	yes	no	3/4"
Calexico	yes	yes	no	3/4"
Daly City	yes	no	.....	5/8"
Dinuba	yes	where people get careless	no	5/8" and 3/4"
El Centro	yes	no	yes	5/8"
Fort Bragg	no	no	.....	5/8"
Fullerton	yes	no	.....	5/8" and 3/4"
Monterey and 3 others	yes	no	.....	5/8" and 1/2"
National City	yes	no	.....	5/8"
Needles	yes	no	.....	5/8"
Oxnard	no	no	no	3/4"
Palo Alto	....	no	.....	5/8", 3/4" connec'ns
Red Bluff	yes	no	no	5/8" and 3/4"
Redding	yes	no	.....	.....
Salinas	yes	no	.....	5/8", 3/4" connec'ns
San Fernando	yes	no	.....	5/8" and 3/4"
Santa Maria	yes	no	.....	5/8" and 3/4"
Santa Paula	no	no	.....	5/8" and 3/4"
So. Pasadena	yes	no	.....	3/4"
Colorado:				
Brighton	yes	no	no	5/8"
Denver	yes	in case of more than one connection	.....	5/8"
Montrose	governed by city ordinances	no	no	5/8"
Sterling	100% meters	no	hot water sometimes warps disk in meter	5/8" and 3/4"
Connecticut:				
New Britain	....	no	.....	5/8" x 3/4", 3/4" & 1"
New London	yes	no	.....	5/8"
Florida:				
De Land	yes	no	yes	5/8" and 3/4"
Fort Myers	yes	no	.....	5/8" and 3/4"
Lakeland	no	no	.....	3/4" and 5/8"
Quincy	yes	no	no	5/8" and 3/4"
Georgia:				
Cedartown	all meters owned by city	no	.....	5/8"
Newnan	no	no	.....	5/8"

Municipality	Can their use be legally required?	Are check valves used at meters?	Have check valves damaged kitchen boilers or house piping?	Size of meters for ordinary residences
Massachusetts:				
Adams	yes	yes	no	5/8" and 3/4"
Fitchburg	yes	only in shops	.....	5/8"
Lynn	yes	no	yes	5/8" and 3/4"
Millbury	yes	no	.....	5/8"
Shrewsbury	yes	no	.....	5/8"
Michigan:				
Coldwater	yes	no meters	.....	.....
Grand Rapids	yes	yes	occasionally	5/8" and 2"
Hancock	....	no	no	5/8"
Iron Mountain	yes	some	no	.....
Royal Oak	yes	no	no	5/8"
St. Joseph	yes	only when troubled with hot water	no	5/8"
Minnesota:				
Alexandria	....	some cases	no	5/8" x 3/4"
Fairmont	....	no	.....	5/8"
Litchfield	....	no	no	5/8", 3/4" spuds
Moorhead	yes	only where hot water on service to steam boilers	no	5/8"
New Ulm	yes	no	.....	5/8"
St. Peter	no	no	.....	5/8"
Mississippi:				
Charleston	yes	no	.....	5/8"
Tupelo	yes	only where boilers are used	no	5/8"
Missouri:				
Chillicothe	yes	no	.....	.....
Fulton	under State Pub. Serv. Com.	no	.....	5/8" x 1/2"
Montana:				
Bozeman	yes	yes	no	5/8" x 3/4"
Havre	yes	where necessary to protect water from hot water	no	5/8"
Kalispell	yes	no	.....	5/8", 3/4" connec'ns
Lewistown	yes	no	yes	1/2"
New Hampshire:				
Newport	yes	no	.....	5/8"
New Jersey:				
West Orange	yes	no	in beginning	5/8"
New Mexico:				
Deming	optional	no	.....	5/8" x 3/4"
Tucumcari	....	no	.....	5/8" x 3/4"
New York:				
Little Falls	yes	no	.....	5/8"
Medina	all metered	no	no	5/8"
Oneida	....	no	.....	5/8"
Owego	....	no	.....	5/8", 3/4" connec'ns
Tonawanda	no	no	.....	5/8"
Whitehall	yes	no	.....	5/8"

Idaho:				
Blackfoot	yes	yes	no	5/8" and 3/4"
Burley	yes	no	no	5/8"
Caldwell	....	yes	no	5/8" and 3/4"
Coeur d'Alene..	yes	yes	no	5/8" and 3/4"
Lewiston	yes	only where power boilers are used	.....	5/8", 3/4" connec'ns
Montpelier	yes	no	no	5/8"
Preston	yes	none used	.....	.....
Welser	yes	no	.....	5/8"
Illinois:				
Hinsdale	by ordinance	no	.....	5/8"
White Hall.....	yes	no	.....	5/8"
Indiana:				
Franklin	yes	no	.....	5/8"
Portland	yes	on steam lines	no	5/8"
Princeton	yes	.....	.....	5/8"
Richmond	yes	factory boilers only if connected direct	.....	5/8"
Rushville	yes	no	no	3/4"
Seymour	yes	if connected with heater	no	5/8" and 3/4"
Shelbyville	yes	where danger from hot water	.....	5/8", 3/4" spuds
Iowa:				
Albia	....	yes	no	5/8"
Cedar Falls....	yes	no	.....	5/8"
Charles City...	....	no	.....	5/8"
Cherokee	yes	stop and waste required back of meter	.....	5/8" and 1/2"
Nevada	yes	only on steam boilers	no	5/8"
Newton	yes	a few	no	5/8"
Oskaloosa	yes	no	yes	5/8"
Winterset	yes	for kitchen boilers	.....	5/8"
Kansas:				
Augusta	yes	no	.....	5/8"
Baxter Springs.	yes	no	.....	5/8"
Concordia	100% meters	on furnace lines	no	5/8" and 3/4"
Council Grove..	yes	no	.....	5/8" and 3/4"
Holton	yes	only where there is chance for back flow of hot water	no	5/8"
Junction City..	yes	no	.....	5/8"
Manhattan	yes	in some cases	no	5/8"
Pratt	yes	no	.....	5/8", 3/4" connec'ns
Kentucky:				
Georgetown ...	no	no	.....	5/8"
Hickman	yes	only where trouble from hot water	one case	5/8", 3/4" connec'ns
Hopkinsville ...	yes	only if hot water backs up	no	5/8"
Maysville	yes	no	no	3/4"
Paris	yes	only to prevent hot water entering meter	.....	3/4"
Maine:				
Calais	no	no	no	5/8"
Gardiner	yes	no	no	5/8" and 3/4"
Rockland	yes	only in case of hot water	.....	5/8"
Rumford	yes	not always	one—where no check was used	5/8"
Maryland:				
Baltimore	yes	no	.....	none to install 5/8", 3/4" services
North Carolina:				
Concord	yes	few	.....	3/4"
Elizabeth City..	optional with Co.	no	.....	5/8", 3/4" connec'ns
Henderson	yes	no	no	5/8"
Kinston	yes	no	.....	5/8", 3/4" connec'ns
Washington ...	yes	in some cases	no	3/4"
North Dakota:				
Bismarck	yes	in some cases where hot water near	no	5/8" and 3/4"
Mandan	yes	no	no	5/8"
Minot	yes	no	.....	5/8"
Ohio:				
Bellevue	yes	no	.....	5/8", 3/4" connec'ns
Bowling Green.	no	few	no	5/8"
Celina	no	no	.....	5/8"
Conneaut	yes	where danger of hot water	no	5/8"
Delaware	yes	not usually	very few	5/8"
Dennison	yes	no	no	5/8"
Greenville	....	where hot water liable to back on meter	no	5/8"
Leetonia	yes	no	.....	1/2"
Logan	no	no	.....	3/4"
Marletta	....	in some cases	no	5/8"
Middleport	yes	no	.....	5/8"
Oberlin	yes	on some services small relief valve	yes	5/8"
Ravenna	yes	when meter near hot water tank	no	5/8", 3/4" connec'ns
Salineville	no	on part of meters	no	.....
Shelby	yes	where required	no	5/8"
Struthers	yes	only where necessary	no	5/8"
Toronto	yes	.....	.....	5/8"
Troy	yes	.....	.....	5/8"
Urbana	no	where necessary	pressure valve with check valve	5/8"
Wapakoneta ...	yes	no	.....	5/8"
Wauseon	no	no	.....	5/8"
Wilmington ...	no	no	.....	5/8"
Oklahoma:				
Blackwell	all metered	.....	.....	5/8"
Clinton	yes	no	.....	5/8"
Commerce	yes	no	some	5/8"
Durant	yes	no	.....	5/8"
El Reno.....	yes	yes	no	5/8" and 3/4"
Guthrie	no	stops	no	5/8"
Henryetta	yes	yes	no	5/8"
Hominy	yes	no	.....	5/8"
Madill	yes	hotels and restaurants	no	5/8"
Miami	yes	on services to boilers	no	5/8"
Norman	yes	no	.....	5/8"
Oklahoma City.	yes	no	.....	5/8"
Okmulgee	....	no	.....	5/8"
Sapulpa	yes	no	.....	3/4" x 5/8"
Oregon:				
Eugene	yes	no	.....	5/8"
Grants Pass....	Pub. Serv. Com. does	no	.....	.....
La Grande.....	city regulations do	except on hot water	.....	5/8" x 3/4"
Marshfield				
North Bend.....	yes	no	no	5/8", 3/4" spuds
Roseburg	yes	no	.....	5/8", 3/4" pipe

(To be continued)

NEWS OF THE SOCIETIES

CALENDAR

July 12-14—NEW ENGLAND ASSOCIATION OF COMMERCIAL ENGINEERS. Exhibition. Auditorium Bldg., Springfield, Mass.

July 18, 19, 20—STEEL METAL CONTRACTORS' ASSOCIATION OF OHIO. Annual convention. Zanesville, Ohio. L. W. Henslee, chairman, convention committee, 623 Putnam Ave., Zanesville, Ohio.

July 19-21—MICHIGAN STATE ASSOCIATION, NATIONAL ASSOCIATION STATIONARY ENGINEERS. Annual convention. Masonic Temple, Kalamazoo, Mich. Secretary, E. C. Smith, 208 W. Vine St., Kalamazoo, Mich.

July 27-28—SHEET METAL CONTRACTORS' ASSOCIATION OF PENNSYLVANIA. Convention. Hotel Lawrence, Erie, Pa. Secretary, W. F. Angermeyer, 714 Homewood Ave., Pittsburgh, Pa.

July 26-28—WISCONSIN STATE ASSOCIATION, NATIONAL ASSOCIATION OF STATIONARY ENGINEERS. Convention and mechanical exhibit. Capitol Building, Madison, Wis. Chairman, convention committee, J. J. Novotny, 2123 Fox Ave., Madison, Wis.

Aug. 15-17—LEAGUE OF IOWA MUNICIPALITIES. Annual meeting. Secretary, F. G. Pierce, Marshalltown, Ia.

Aug. 15-18—INTERNATIONAL ASSOCIATION OF FIRE ENGINEERS. Fiftieth convention. Municipal Auditorium, San Francisco, Cal. Secretary, James J. Mulcahey, Chief, Yonkers, N. Y., Fire Dept.

Aug. 28-Sept. 2—NATIONAL SAFETY CONGRESS. Detroit, Mich.

Sept. 11-15—ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS. New Auditorium, Cleveland, Ohio.

Sept. 12-15—NEW ENGLAND WATER WORKS ASSOCIATION. 41st annual convention. New Bedford, Mass. Secretary, Frank J. Gifford, Tremont Temple, Boston, Mass.

Sept. 25-28—SOUTHWEST WATER WORKS ASSOCIATION. Annual convention. Hot Springs, Ark.

Oct. 1-6—AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS. Annual convention. Cleveland, Ohio.

Oct. 16-19 — AMERICAN PUBLIC HEALTH ASSOCIATION. Annual meeting. Cleveland, Ohio.

Nov. 15-16—NATIONAL INDUSTRIAL LEAGUE. Annual meeting. New York City. Secretary, J. H. Beek, Chicago.

Dec. 7-13—NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING. New York City.

AMERICAN SOCIETY OF CIVIL ENGINEERS

The most important action of the Board of Direction in its two-day session prior to the annual convention of the society at Portsmouth, N. H., June 21-22, was the election of John H. Dunlap, of Iowa City, Iowa, as secretary, establishment of technical divisions of the society and a step forward in the settlement of the question whether the society should join the Federated American Engineering Societies.

Professor Dunlap has been secretary and president of the Iowa Engineering Society and is now the president of the Iowa section of the American Society of Civil Engineers.

The by-laws adopted by the Board of Direction permit the formation of technical divisions on the application of 20 members, the division then being authorized to include non-members in its activities.

The question of joining the Federation was deferred until the San Francisco meeting to be held in the Fall.

The following were elected to honorary membership: W. C. Unwin, and Sir Maurice Fitzmaurice, eminent British engineers; Clemens Herschel, hydraulic engineer, New York; John F. Stevens, president, Inter-Allied Technical Board, Harbin, Manchuria, and M. Chagnaud, president, Société Française des Ingénieurs Civils.

Very little business was transacted at the meeting. Weather conditions were such as to prevent any outdoor events, and this permitted the presentation of nine technical papers, which were as follows: L. C. Wason, president of the Aberthaw Construction Co., reported on the well-known Aberthaw tests of concrete piles. The paper was read by a member of his staff. Col. W. G. Atwood read a paper on the activities of the marine borer which is abundant in the Pacific Coast waters. Prof. W. K. Hatt presented a report on the various tests on highways. Wood pulp was the subject of three other papers, these being "Pollution of Streams by Paper Mill Wastes," by Prof. George C. Whipple; of Harvard University, the chemical aspects of the same subject by H. W. Clark, chief chemist of the Massachusetts State Board of Health, and the wood pulp industry in general by E. B. Wardle, chief engineer of the Laurentide Co. of Canada. The Gouin Dam, Quebec, was described by J. H. Brace, of the contracting firm of Fraser, Brace & Co. The problems in connection with the St. Maurice River regulations provided material for a paper by O. Lefebre, chief engineer of the Quebec Streams Commission. The evening closed with an illustrated talk by J. W. Rollins on the foundation work of the Piscataqua bridge at Portsmouth.

CONSTRUCTION COUNCIL

After a two-days session at Washington, D. C., 200 delegates, representing architects, engineers, general contractors, sub-contractors, construction labor, material and equipment manufacturers and dealers, financial, bond, insurance and real estate interests, public utility construction departments, Federal, State, County and Municipal Associations elected as president Franklin D. Roosevelt, formerly Assistant Secretary of the Navy. An executive board of 44 members was elected.

In an address to the council, Secretary of Commerce Hoover stated that the whole question of construction and the problem of construction increase in our national plant can be separated entirely from the problem of production, and that the organization of these industries to perform their best and highest functions is one of the things needed above all in this nation.

W. G. Merritt, attorney, New York, urged a method of arbitration as one of the most important things for the Council to accept, and said that all contracts should be subject to arbitration in accord with the rules of the Council, and that one of the greatest evils in the industry is the bargaining with corruption for fear that any attempt to uncover that corruption will embarrass future relations.

Among the other principal speakers were Willis H. Booth, vice-president of the Guaranty Trust Company of New York; M. T. Bannigan, president of the National Building Supply Dealers' Association; Henry H. Kendall, past president of the American Institute of Architects; William McClellan, of New York, representing public utilities construction; Ralph F. Proctor, of the Maryland Casualty Company of Baltimore; Frederick L. Cranford, vice-president of the Associated General contractors of America; James A. Emery, counsel for the National Manufacturers' Association, and Thomas R. MacDonald, chief of the Bureau of Public Roads, who emphasizes the relationship of the highway industry with the whole construction industry.

The immediate program of action suggested for the new Council as a result of its deliberations includes:

The formation of a code of ethics acceptable to the whole industry and to the public.

The gathering of adequate statistics from all sources and resulting interpretation.

The reduction of the national shortage of building trades mechanics and the establishment of the necessary apprenticeship system.

Co-operation in establishing uniform building codes throughout the country.

Co-operation with the railroads in expediting the revision of existing freight rates on construction materials. The establishing and strengthening of local organizations throughout the country to bring about the co-operation of all elements in conformity with the principles of the Council.

The mitigation of the evils of seasonal employment and trade migration of labor.

The encouragement of local building shows.

Simplification, standardization and elimination of waste.

Education of the public to the distribution of its construction and maintenance requirements more evenly throughout the year.

The promotion of health and safety of workmen.

The reduction of loss of life and waste of construction materials from preventable fires.

The study of old building in order to establish superior methods of construction.

The education of the public as to the necessity and economy of properly maintaining existing structures.

CLEVELAND ENGINEERING SOCIETY

In connection with its recent annual meeting the society made an all-day inspection of the public works in the city. Among the places visited were the pumping station, the municipal bath house, the municipal light plant; the Fairmount and Baldwin reservoirs, the sewerage treatment works, and the filtration plant.

THE CINCINNATI SECTION OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

At a joint meeting with the Cincinnati Engineers' Club, held recently, Dean M. E. Cooley, president of the Federated American Engineering Societies, was the principal speaker.

THE SAN FRANCISCO POST OF THE AMERICAN MILITARY ENGINEERS

The chief speaker, at a recent meeting, was Frank G. White, chief engineer, state harbor commission, who spoke on "Harbors and Terminals: The Port Facilities of San Francisco Bay."

THE WEST AUSTRALIAN BRANCH OF THE AUSTRALIAN INSTITUTE OF ENGINEERS

The following officers were elected for 1922-1923: Chairman, W. H. Shields; Vice-Chairman, T. M. Carey; Secretary, Assistant Professor Tomlinson, and Treasurer, J. Andrews. Members of the committee are R. H. J. Clarke, A. W. Galbraith, H. T. Haynes, P. V. O'Brien, J. Parr, and W. K. Weller.

AMERICAN ROAD BUILDERS' ASSOCIATION

The annual meeting of the association held in New York City on June 15 received from the board of directors the announcement of the election to the presidency of Thomas J. Wasser, state highway engineer of New Jersey, as successor of Lieutenant-Colonel H. L. Bowlby. The board's action broke the deadlock which ended the meeting on May 15, when there was a tie vote between Mr. Wasser and Colonel W. D. Uhler, state highway engineer of Pennsylvania.

LUMBER STANDARDS CONFERENCE

At the conference of Lumber Trade Association in Washington May 22-26 producers and consumers met to promote the standardization and guarantees of quantity and quality of lumber shipments. The report of their activities includes recommendations for the simplification of grades, the standardization of sizes and for the guarantees of grades and quantities. It is proposed that all lumber shall be placed in three main subdivisions: (a)—representing the best qualities; (b)—representing the intermediate qualities; (c)—representing the common qualities.

Action was taken looking toward the establishment of a central bureau for uniformity of grading and inspection and re-inspection.

It was proposed to make a survey determining the feasibility of nationally supervised inspection and a report was made on the standard sizes that has been agreed upon.

THE AMERICAN ENGINEERING COUNCIL OF THE FEDERATED AMERICAN ENGINEERING SOCIETIES.

The meeting of the executive board at Pittsburgh was closed May 27. During the session resolutions on the licensing of engineers were approved, the engineers' employment service was reorganized and the committee on regional activities reported progress on the preparation of a plan for the affiliation of local and state organizations.

It was decided to submit to President Harding a report on federal water power projects in which there will be incorporated criticism of the activities of the federal water power commission.

The organization of government administrative officials was recommended and consideration was given to the important engineering problems of flood control, reforestation, jurisdictional labor awards, patent legislation, waste in agriculture and more intensive engineering organization.

PERSONALS

Hathaway, C. M., district engineer of the Illinois State Division of Highways, has been appointed engineer of construction to succeed B. H. Piepmeier, who resigned to become State Highway Engineer of Missouri.

Campbell, Henry P., senior assistant engineer of Indianapolis, resigned recently to enter a private engineering firm. Melnott N. Beebe, street engineer, has been promoted to his position, while William Lacey, an assistant engineer, has been made street engineer.

Burke, Col. Richard O'Sullivan, for many years engineer of harbor work for the city of Chicago, died on May 11 at the age of 84.

Knauer, William J., county engineer of Chautauqua County, N. Y., with offices in Jamestown, has resigned and will engage in private contracting work.

Stanchfield, G. H., has been made city engineer of Fond du Lac, Wis., to succeed R. B. Petters, who resigned recently.

Dimsdale, H. G., engineer of the Lacombe Northwestern Ry., has been appointed Highways Commissioner of the Province of Alberta, Can.

Earle, Roscoe K., former city engineer of Davenport, Ia., has opened offices in that city, where he will specialize in town planning, sewerage, water supply, flood relief, drainage, paving, surveying, etc.

Dill, C. W., Superintendent of Highways for the Saskatchewan Government, has resigned after occupying the position for over three years.

Adams, James C., deputy city engineer of Binghampton, N. Y., has resigned.

Fluker, T. R., has been appointed manager of the commission form of government of Quitman, Ga.

Robert Whitten has opened offices at 4614 Prospect avenue, Cleveland, Ohio, where he will practice in general city planning and city zoning. He will be associated with A. D. Taylor, landscape architect and town planner.

Fletcher, R. H., has resigned from the Montana State Highway Department to become city engineer of Helena.

Brown, Julius, has been appointed county engineer of Rock county, Minn., with headquarters at Luverne.

Trowbridge, C. G., city engineer and superintendent of construction, Decatur, Ga., has resigned.

Hurtgen, P. J., has been appointed city engineer of Kenosha, Wis., to succeed B. C. Brennan, resigned.

Lozier, W. L., of Rochester, has been appointed engineer in charge of public improvements, Seneca Falls, N. Y.

Rice, C. E., city engineer of Wooster, Ohio, has resigned.

Balknap, Leslie H., deputy state highway commissioner, Lansing, Mich., has resigned and will be succeeded by G. C. Dillman, an engineer in the department of maintenance.

Manning, J. P., has accepted the position of city manager of Sapulpa, Okla.

Williams, John D., who has been connected with the Indiana state government since 1906, has been appointed director of the state highway department, to succeed Lawrence Lyons, whose resignation was tendered to the commission on May 16th.

Deckman, C. J., for many years president of the National Paving Brick Manufacturers' Association, and vice-president of the Medal Paving Brick Company, until his retirement in 1917, died on June 26.

Hull, Walter L., City Engineer of Orange, N. J., died June 20 after a very short illness. At an early age, Mr. Hull began his professional career in the city engiher's office, Brooklyn, and was afterwards employed by the New York Central Railroad, the Lackawanna Railroad, and in the construction of the Pennsylvania tubes under the North River, where he sustained injuries from the air pressure from which he never fully recovered. He had been city engineer of Orange for the past three years.

New Appliances

Describing New Machinery, Apparatus, Materials and Methods and Recent Interesting Installations

BUCYRUS UNIVERSAL SHOVEL RIGGED AS DRAGLINE MACHINE.

A NEW ¾ YARD UNIVERSAL SHOVEL

The Bucyrus Company has just announced a new 20-ton ¾-yard revolving shovel to be known as the 20-B, which replaces their 14-B revolving shovel. From boom point to ash pan, this is a distinctly new design. It is a "Universal" machine, being adaptable to dragline, high lift, sewer, clam shell, crane and other combinations.

The new and exclusive features include a two-part instead of a three-part hoist, whereby the dragline excavator can be made as good a dragline as the shovel is a shovel, wear on rope is reduced, a shorter rope is required, and faster digging speed is made possible without sacrifice of power.

This shovel also has the outside type of dipper sticks and box girder type of boom, the strongest possible construction for successfully withstanding twisting and wrenching strains.

The A-frame is directly connected to a steel center casting, and the back leg instead of being attached to a structural rear end is also connected to this casting. The dipper has all four corners rounded.

This shovel is extremely easy to operate. It is equipped with an improved and simplified three-lever control. One lever controls the independent operation of the throttle and the ram. Furthermore, a release throttle is provided whereby the dipper may be lowered without the need of applying the brake.

The boiler has a larger heating surface and grate area than that of other ¾-yard shovels and is further equipped with a patented scale chamber, making it possible to work with poorer water, with greater steaming efficiency and with less delay.

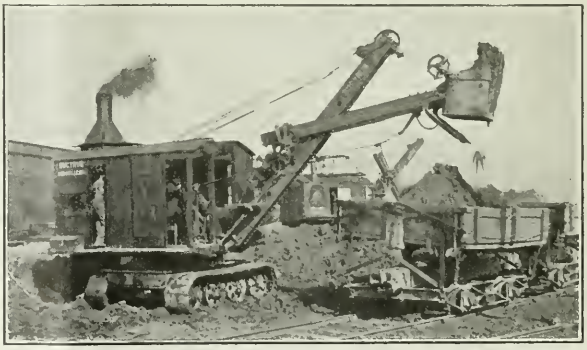
A further unique feature of this shovel is a device whereby the stack may be lowered by power, thus eliminating the possibility of damaging the stack and the rear of the house. Accessibility and simplicity of upkeep are prominent in the design throughout. One instance thereof is the ability of lifting out the vertical propelling shaft from the top instead of extracting it from the bottom, and another, the fact that the swing rollers are arranged so that they may be removed without the necessity of jacking up the frame.

The crawlers are a distinct improvement over any other type. They contain less than half as many individual parts as the next simplest type built. There are only two rollers in each crawler. These are of large diameter with bearings high out of the mud and water. The driving is through direct gearing to the tumblers, no chains are used. The elimination of the side frames increases the accessibility and ease of repair and adjustment. The rollers may be removed without even disconnecting the crawler chain.

The links are of one piece, made of a specially selected and a specially treated steel. The pin connections are on the outside, not at the center. This assures a straight travel and prevents damage should a link strike an obstruction on its edge. There are only 23 links in each crawler. They form a perfectly smooth platform with no gaps between the links to pick up rocks and act as small jaw crushers. They won't rip up a pavement. This shovel has easily climbed out of a muddy pit on a 20 per cent grade of slippery clay. The crawlers do not extend at either end beyond the distance occupied by the traction wheels, a feature which is of great importance for digging in small basements.

For operation in the pit, where a pit-man is always available, a simple and effective hand steer is provided. The clutches are on the outside where they are accessible and high out of danger of getting clogged with mud. There are no links and rods to get out of order. For moving from job to job a patented power steering wheel is provided. This is an absolutely unique and exclusive feature of the 20-B. It consists of a rubber-tired wheel which is easily and quickly attached to the front of the dipper. Steering is accomplished merely by pointing the boom in the direction of travel. The crawlers track after this wheel. With this wheel it is possible to travel four blocks while shovels with other types of power steer are traveling two or three.

Another unique feature of this machine is the use of electric steel in the smaller castings, making possible the most economic distribution of material.



BUCYRUS UNIVERSAL SHOVEL RIGGED WITH DIPPER HANDLE AND CONNECTING ENGINE

PUBLIC WORKS.

CITY COUNTY STATE

A Combination of "MUNICIPAL JOURNAL" and "CONTRACTING"

Vol. 53 July 15, 1922 No. 3

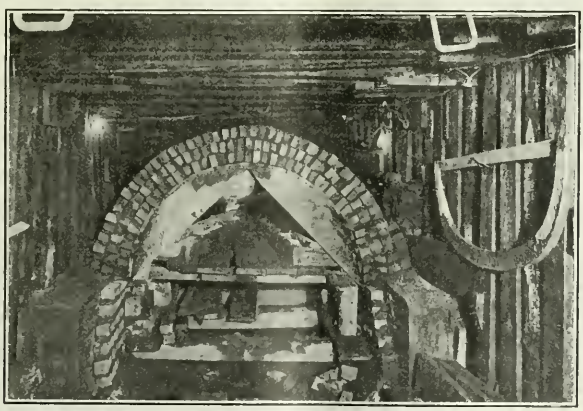
Negley Run Relief Sewer

Construction of 3,548 feet of 72 and 78-inch brick and concrete sewers in open trench and tunnel, with trench excavation backfilled by traveling overhead machine.

The Bennett street section of the relief sewer in the Homewood Brushton district of the Negley Run drainage basin, Pittsburgh, is about 5,000 feet long and has cost about $258,000. It includes 3,800 feet of 3-ring brick sewer 6 feet in diameter and 1,200 feet of 78 x 75-inch concrete sewer. About 700 feet of the brick sewer was built in a 9-foot 6-inch diameter rock tunnel driven from two shafts. The remainder of the brick sewer and the reinforced concrete sewer was built in an open trench with a maximum depth of 32 feet. The work was designed and supervised by the Bureau of Engineering, Department of Public Works, John Swan, director, C. M. Rippert, chief engineer, and I. C. Palmer, assistant chief engineer in charge. Christ Donattelli was awarded the contract March 3, 1921, and commenced the work March 16, and has carried it on with an average force of 60 men.

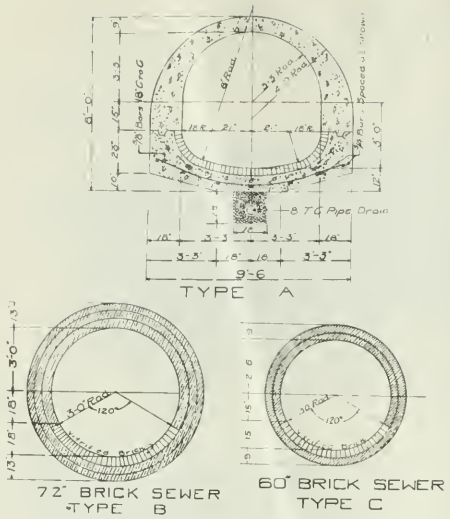
The contract includes 22 manholes, two catch-basins and numerous inlet connections, short lines, small terra cotta pipe, four intersection chambers and the connection with an existing relief sewer. The sewer makes two 90-degree long-radius bends and has several sharp grades following the surface slopes.

The trench excavation was largely in dry earth requiring little pumping except for surface drainage. The upper strata are loose and unstable, requiring in some places sheeting of two tiers of 2-inch wooden planks driven by hand mauls as the excavation progressed and braced with a maximum of eight tiers of cross braces, adjustable jack-screws being used. In some places the upper strata were hard and stable so that sheeting was required only in the upper part of the trench.



BUILDING BRICK ARCH SECTION IN TUNNEL.

The soil was excavated by pick and shovel and then, in the trench work, was loaded into four half-yard steel buckets hoisted by the traveler of a Potter conveyor installation equipped with 400 feet of movable trestle mounted on a 9-foot gauge track laid on the surface of the ground alongside and spanning the trench. The traveler was traversed and the



STANDARD SECTIONS OF SEWER.

hoist operated by three cables run to a Lidgerwood double drum hoisting engine installed on a movable independent platform at the end of the conveyor track.

The soil was thus hoisted as excavated, carried back to a section over the finished sewer and deposited there for backfill at one operation without rehandling. As fast as the excavation and sewer construction advanced a hundred feet or more the conveyor machine and its engine were moved forward to command the section under construction. With this equipment a force of about 20 men was able to excavate and backfill about 45 yards of earth in one ten-hour shift.

The concrete sewer, 78 inches wide and 75 inches high inside, has reinforced concrete invert lined with vitrified brick and is 9½ feet wide and 8 feet high over all, containing about 1.05 cubic yards of concrete per linear foot of finished sewer. After the excavation was completed a trench 18 inches wide and 18 inches deep was dug in the center line and filled with broken stone surrounding an eight-inch terra cotta drain pipe laid with open joints.

The sewer was built in two operations, the invert being constructed up to a total height of 4 feet above subgrade by the usual method, with wooden top forms made in 10-foot lengths. A longitudinal recess was provided in the top of each side of the invert wall to bond with the key of the arch concrete poured in 20-foot sections over wooden forms adjusted by wedges.

The upper parts of the side walls and the arch were concreted in a single operation with three 20-foot sections of Blaw-Knox forms adjusted by wedges and shifted on a car traveling on the 24-inch service track in the invert. The concrete was mixed in a portable quarter-yard Ransome machine moved along the side of the trench and delivering through short wooden chutes to the forms as required.

This section of the sewer was built at a rate of 10 feet per day by an average force of 20 men working at the forms and concreting and 40 men excavating and backfilling.

The 700 feet of tunnel about 10 feet high and 7 feet wide was excavated at the rate of about 5 linear feet per ten-hour shift in each of two headings from each shaft (four headings in all) by average forces of 8 men per heading per shaft. It was permanently timbered with bents about 2 feet apart in the clear between the 6 x 8-inch timbers. After the subdrain was laid the invert and lower part of the side walls were concreted in one operation, after which the vitrified brick invert lining was laid, and the three-ring brick arch was built in 12-foot sections supported on ordinary timber centers.

Blowing Fine Material from Sand

Loose sand containing 20 per cent. very fine material was made satisfactory for concrete road building purposes in California by subjecting it to a blast from a centrifugal blower while falling through a narrow opening from a hopper to a storage bin. The blower was operated by the engine driving the revolving screen through which the sand was first sifted. Regulating the air pressure enabled any desired proportion of the fine material to be blown away and reduced its amount to below the five per cent admissable by the specification. This method was found profitable with dry sand.

CONVEYOR SYSTEM FOR HANDLING SOIL TO BACK-FILL.

Road Work in North Carolina Mountains

By Ray S. Blinn*

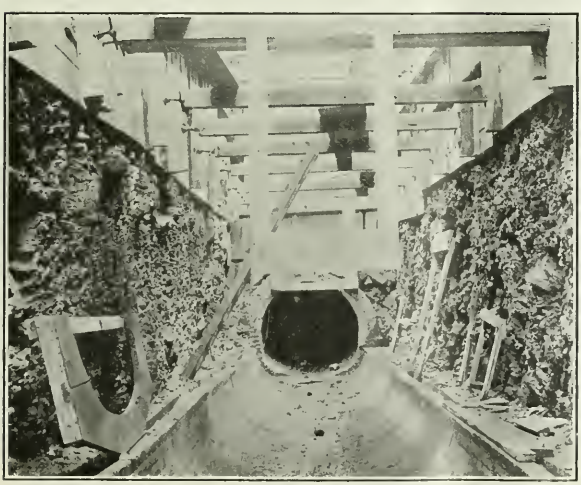
Alleghany county, N. C., lies on a high broken plateau between the Blue Ridge and Peach Bottom mountains at an elevation of about 3,500 feet above sea level. There are no railroads in the county. A federal aid highway project under state supervision is now being constructed from the southeast to the northwest through the county.

The county is undertaking to improve about 40 miles of roads tributary to the federal aid highway by grading and constructing culverts. In these tributary roads, ruling grades are fixed at 5 per cent. and compensated for curvature, although on short stretches grades as high as 7 per cent. are used but are capable of reduction later. The soil is principally loam with red subsoil, although gneiss in upended strata is frequently met with. The road is graded 20 feet wide, with an 18-inch crown measured from the bottom of the side ditches. The grading varies from about 10,000 to 6,000 yards per mile and 18 miles of it has been contracted for at 38 cents per yard for unclassified excavation. The average cost, including culverts and bridges, is expected to be kept well under $4,000 per mile. It is proposed to maintain the roads by dragging and to gradually improve them by top-soiling, as is common practice in North Carolina.

The district being so inaccessible, the matter of culverts and bridges was the most difficult problem. No material from outside of the locality is being used except structural hardware such as drift bolts, nails and tie rods. As the county contains abundance of white oak, with chestnut oak, water oak and chestnut also available, it has been decided to construct all small culverts of plank and to use logs for the larger openings and wooden bridges for spans above 10 feet. This decision was reached because of (1) excessive cost of transporting cement, crushed stone and sand for concrete, (2) cheapness of white oak timber, (3) replacement cost of timber is less than the annual carrying charges for more permanent structures, (4) there are no existing openings to serve as guides in determining size of water ways, (5) topographical maps are not available for studying run-off problems accurately.

It is estimated that white oak or any of the other timbers named will last at least 10 years and possibly 20 years without renewal.

* Locating engineer, Mount Vernon, Ohio.



BUILDING CONCRETE SECTION IN DEEP, OPEN TRENCH.

Pennsylvania State Highway Equipment

Plant and mechanical apparatus kept for maintenance work on 10,200 miles of improved highways of many types. Costs, repairs, renewals, rentals, etc., systematically accounted. Plant issued on requisition and charged and credited to respective jobs.

The rapidly increasing annual motor vehicle traffic in Pennsylvania is carried over the great north-south, and east-west trunk lines connecting the principal centers of manufacturing and population and the secondary lines connecting the smaller towns and villages which form the 10,200 miles of the State highway system. These roads are maintained by an important division of the State Highway Department through its staff of 139 salaried employees including 15 district engineers of the districts into which the State is geographically divided. It has a maximum of 10,000 skilled and unskilled laborers who constantly patrol the roads and perform the routine and special services required to preserve the wearing surface, repair the wear and tear on it and in many cases remove the snow in winter.

The equipment bureau which forms part of the Management Division, has its principal headquarters at Harrisburg. It has a staff consisting of equipment engineers, mechanician, chief inspector, assistant inspectors, foremen, clerks, mechanics, helpers, and chauffeurs. It is supplied with a variable and increasing amount of mechanical equipment with a present inventory value of about $2,600,000, which is stored at large yards and warehouses in Harrisburg, Greensburg, Chambersburg, Gettysburg, Hollidaysburg, Witmer, York, West Chester, Langhorne, Bedford, Media, Washington and Uniontown, and at depots established in each of the 15 geographical districts.

There are, besides, quantities of road-building materials, such as broken

stone, sand, cement, bricks, asphalt, culvert pipes, guard rails, etc., kept in storage at various central points and sand pits and quarries are located and operated at several places where suitable deposits have been found. It is estimated that in 1921 a total of about $3,700,000 worth of materials were used for maintenance purposes and $5,000,000 expended for labor, while the mechanical equipment, rental and supplies if computed on the usual commercial basis probably amounted to $900,000.

PRINCIPAL EQUIPMENT

An approximate list of the items of mechanical equipment owned by the department last fall included 765 one-ton to five-ton motor trucks with dump and cargo bodies of miscellaneous make, including Packard, Pierce-Arrow, Denby, Kelly-Springfield, Nash, Gartord, International, and light and heavy aviation trucks; 161 automobiles of which 74 were Ford roadsters, 4 Cadillacs, 7 Franklins, 1 Stutz, 31 Dodge, 42 touring Fords, 1 Hudson, 1 Personell and 1 Hupmobile. There were 102 450-gallon sprinklers of miscellaneous makes, 41 street sweepers, 1 Kinney road planer, 8 locomotive cranes of 20 to 30-ton capacity, and of Browning, American and other makes, 58 chip and gravel spreaders, 9 Baker-Maney wheel scrapers, 24 4,500-pound Buffalo-Pitts scarifiers, 272 road machines (mostly Champion), 79 5-ton Holt tractors and 25 tractors of miscellaneous makes, 191 Watson 1-1½ yard dump wagons, 19 gasoline driven Ingersoll-Rand and Schram air compressors, 10 Wood steam-driven tripod rock drills, 110 gasoline pumps of miscellaneous makes, 90 10-ton Kelly-Springfield, Austin and Buffalo-Pitts rollers, 43 9/16-inch jaw crushers mostly Champion No. 3 and No. 4, 16 Frick, Russell and Farquhar tractor engines, 25 Ransome, Koehring, and Austin and Western Road Machinery Co. concrete mixers, 12 gasoline driven 24-inch gage locomotives, 5 of Bell, 1 of Reed, and 6 of Whitcomb make, and 4 Davenport (steam), 131 Koppel one-yard dump cars, 5 Lakewood concrete finishing machines, 5 Lakewood concrete subgrader machines, 5 Osgood 3/4-yard steam shovels, 3 Baker asphalt surface heaters, 5 Bell truck trailers, 7 Good Roads Machinery Co.'s stone unloaders, 17 steam hoists, 2 5-ton derricks, 1 Warrenite asphalt portable plant, 1 Allentown Cement Gun Co.'s cement gun, 21 150 to 400-gallon Baker asphalt heating kettles, 10 one-yard dump carts, 86 Alger and Syracuse road plows, 64 rooter plows and 69 snow plows mostly made by the Good Roads Machinery Co., 20 Farquhar 30-horsepower steam boilers, 51 blacksmith forges, and 22 Good Roads Machinery Co. electric firing batteries.

DISTRIBUTION

On the 25th of each month, each of the 53 district superintendents files a monthly distribution and available report of equipment, listing the equipment located in his district that is available and will be transferred upon given dates. This is made out on a printed form ruled with eight vertical columns with the titles—department number, kind of equipment, route of application, charge number, date available for transfer, to be transferred when available to (sub-titles, route or application, charge number and shipping point).

At the bottom of the same page there is a space headed "I am in need of the following equipment which is not available in my district" and ruled in seven vertical columns for the titles—department number, kind of equipment, route or application, charge number, date desired, estimate of time to be used, and shipping point. The sheet is approved by the district engineer and signed by the superintendent.

Requisitions for equipment are made out on standard 7 1/2x8 1/2-inch blanks giving serial number and date and requesting that equipment be furnished as shown by entries in seven columns titled—quantity, size, kind, desired, promised, ready, and delivered; to which is added statement of route, application, county, township or borough, kind of work, directions for delivery, signature of receiving official and memorandum of condition when delivered, and of tool equipment signed by the official and countersigned for acceptance.

TRANSFERS

Orders for transfer of equipment are made out on 4¼x9¼-inch cards approved by the assistant engineer and signed by the superintendent of one district and addressed to the superintendent of another district, who is instructed to transfer the designated equipment not later than a given date to a given place via given route corresponding to the required route, county, application and charge number, and with State Highway Department bill of lading and memorandum copy forwarded to district engineer. The card has blanks for description of condition of plant, repairs necessary, date of shipment, department bill of lading number, signed by the superintendent and approved by the district engineer, and returned to the Maintenance Division.

Rapid Erection of Trolley Bridge

A six-panel trestle bridge of the Holyoke Street Railway across a canal was erected in seven hours by a simple method and with practically no equipment except a donkey engine and cable, some track ties and the material of the bridge, smoothness and rapidity being secured by working out the plans and making all arrangements in advance for the uninterrupted procedure of operation.

The steel stringers were bolted together to form three 50-foot sections, two of which, on opposite sides of the canal, projected nearly half their length beyond the water line while the canal was being drained. As soon as the canal was drained, the extremities of the cantilever arms of the stringers were supported on cribs made up of track ties, and transverse bents to form the two center towers were slipped over them to bearings on mud sills, revolved into position, braced and guyed, after which the transverse bents were revolved from inclined to vertical position bringing the 50-foot sections of stringers to the required position and level as they were moved by the hoisting engine. The third 50-foot section of stringers was then rolled out over the end sections to position and the bridge was completed and the cribbing removed and water admitted to the canal.

Hetch Hetchy Dam Excavation

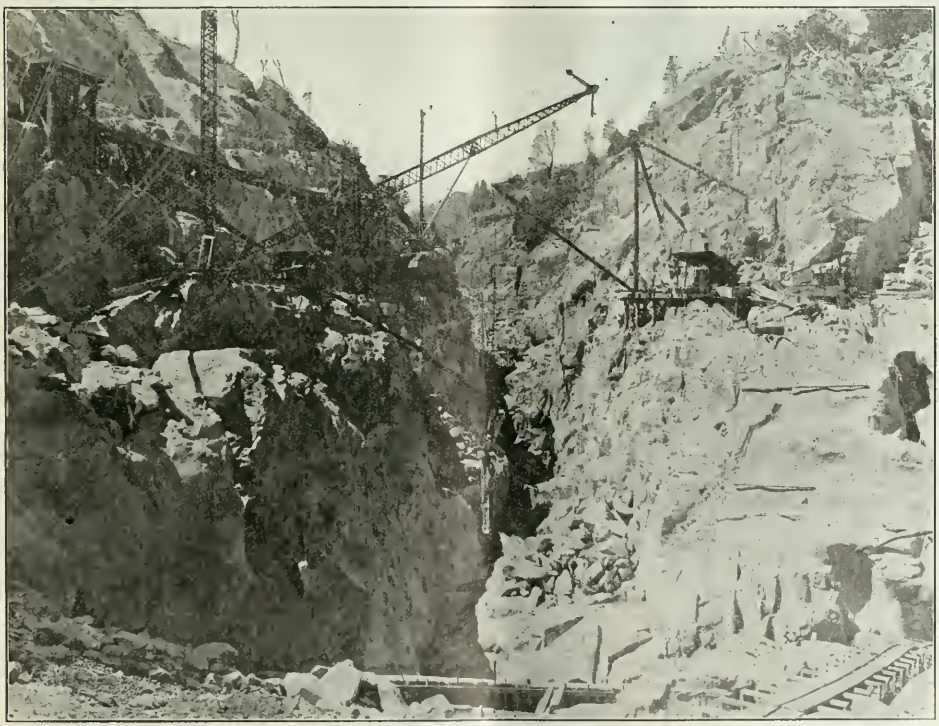
145,000 yards of earth and rock in pit 117 feet deep handled, to a depth of 67 feet, by steam shovels and dump cars hauled up 20 per cent grade. Rock surfaces sand blasted. Men lowered 500 feet to bottom of pit in cableway skip.*

The Hetch Hetchy dam now being constructed to impound the run-off from a water shed of 459 square miles in the Sierra Nevadas and store it for the water supply of San Francisco is built across a very narrow portion of the granite rock canyon in which the Tuolumne river flows, about 3,500 feet above sea level. The sides of the canyon are very precipitous and, like the bottom of the canyon, are composed of very hard rock which is especially well adapted to support the dam and resist the ultimate hydraulic pressure of more than 300 feet head, especially because the bed rock under the stream bed slopes upward in the downstream direction and the converging sides of the canyon are here very steep and very close together.

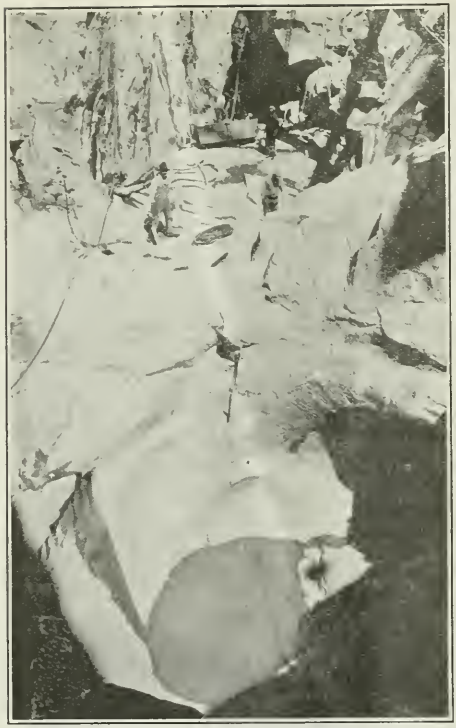
The dam has cyclopean concrete everywhere resting on sound, hard rock. To secure this involved the removal of loose and weathered portions on the sides of the canyon and the excavation through earth, loose rock and unsound strata to a maximum depth of 117 feet below the original bed of the river. The material so removed comprised 65,000 yards of earth and loose rock at a unit price of $8 when below the original stream bed and $1.50 per yard above that elevation, and 100,000 yards of solid rock at prices of $11.20 below and $3 above stream bed, according to the terms of the contract awarded by the city of San Francisco, August, 1919, to the Utah Construction Co., which immediately commenced operations and substantially completed the excavation in about 20 months.

The foundation, extending across the full width of the canyon with a maximum width transverse to the canyon of more than 300 feet, passed through surface material of such a character that it was anticipated it would prove so permeable that full depth open cut work would be impracticable, and provisions were made for continuing it with the pneumatic caisson process if necessary to carry it to the required depth below streambed, which eventually proved to be 117 feet below the bed of the stream and 146 feet below flood level. Materials were

* Article describing dam and river diversion work was published July 8th.



GENERAL VIEW OF EXCAVATION FOR HETCH HETCHY DAM, SHOWING DERRICKS INSTALLED FOR HANDLING ROCK FROM BOTTOM OF PIT, AND CHUTE FOR CONCRETING LOWEST PART OF FOUNDATIONS.



POT HOLE ENCOUNTERED IN EXCAVATION 100 FEET BELOW ORIGINAL STREAM BED.

therefore delivered in advance to the dam site for the construction of the cutting edges of the pneumatic caissons, but it was not found necessary to use them. Completion of the work by open excavation was made possible by the efficient provisions made for intercepting surface water, the existence of an impervious subterranean stratum which greatly reduced seepage into the pit, and the installation of a powerful pumping plant operating from high level and low level sumps and able at all times to care for all the water encountered with an ample excess of reserve capacity.

Great pains were taken to divert the river water by means of a crib dam with cut-off wall described in the previous article, and to deflect the flow to a tunnel, 900 feet long, passing around one end of the dam and discharging into the river channel just below a small permanent cofferdam consisting of a concrete structure about 46 feet long, 3 feet wide on top and about 23 feet wide at the bottom which was built to a height of 35 feet in a trench excavated in the rock 10 feet below the bed of the river. The top of the dam was 23 feet above water level, at which level the structure was pierced by a 30-inch horizontal pipe open at the upstream end and closed at the downstream end by a movable casting.

The stream diversion dam was made nearly at right angles to the axis of the permanent dam, the near point being about 100 feet from the latter, so that the side of the pit of the permanent dam was allowed to take a natural slope towards the diversion dam until excavation reached a depth of 53 feet below the foundations of the diversion dam, when it was assumed that a deeper slope might produce instability of the diversion dam.

A slope of about ½ to 1, blanketed with course material, was thus maintained until the excavation reached a depth of about 60 feet, and to prevent increasing the angle of the slope, the bank was retained by the construction of a concrete wall about 150 feet long and 35 feet high built in a timbered trench approximately parallel to the axis of the main dam. This wall was for retaining the material above, but the foundation was not made watertight. But although the excavation was carried below the bottom of this retaining wall and considerable seepage occurred through the coarse material below it, no serious difficulty resulted, and

DOWN-STREAM RETAINING WALL. 12-INCH BYRON JACKSON PUMP INSTALLED ON BARGE.

settlement of the wall was prevented by breasting the lower 27 feet of the excavation at this point.

Excavation was started on both sides of the canyon at the ends and top of dam, and slopes cleaned down to river bed. Drilling was all done with Ingersoll-Rand jackhammers, air for which was furnished by two Sullivan cross compound com-

pressors of 1,000 and 2,000 feet capacity. All excavated material was handled at stream bed level with a Marion 36 crawler shovel which loaded 4-yard 36-inch gage Western dump cars, hauled by 18-ton Porter dinkey engines. As excavation was carried below the stream bed, trains were worked on inclines, increasing to a maximum of 20 per cent. slope, which was double tracked, empty trains going down helping loaded trains out by use of a cable rove through a sheave on the dump above. Excavation was carried in this way 60 feet below stream bed, at which time the walls were narrowing so that the steam shovel had to be taken out.

Usually the shovel worked 10 feet deep on each side of the canyon. The steepness of the canyon walls was so great as to make the work slow and the danger from falling rocks prevented men from working at more than one level simultaneously. The scaling gangs above the shovel were alternated from side to side of the canyon so as to work when the shovel was on the opposite side.

Spoil from the lowest 57 feet was loaded by hand into 4-yard skips and hoisted with two 100-foot steel Insley and two 56-foot wooden derricks and 2-yard skips dumped into cars on tracks, located 40 feet above stream bed on either side of the canyon, which handled about 20,000 yards of rock.

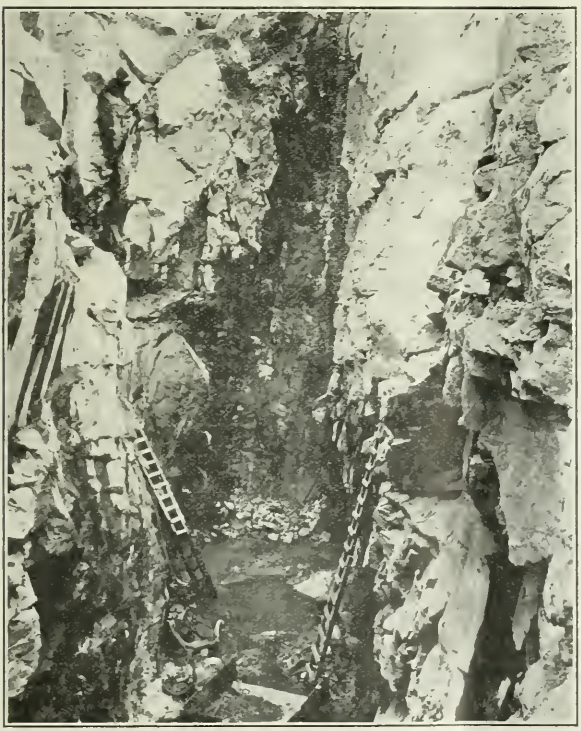
The service track on which the spoil was carried to a dump in the river valley below the dam continued to the crusher plant and delivered broken stone for concrete in the later stages of the work.

As the excavation proceeded, the seams in the rock were thoroughly cleaned out to their full depth and the extremely irregular surface so formed provided excellent anchorage for the mass concrete. Notwithstanding the superficial fissures, the body of the rock was so sound and tight that no percolation or leakage came from the high-level diversion tunnel which was only a few feet from the excavation and it was found unnecessary to do any grouting.

Although the rock of the canyon was remarkably sound and solid, nearly all of the surface above stream level was removed. Below the level of the river bed, where the rock had not weathered much, less surface trimming was required. Loose sand and dirt were removed by washing and wire brushes and the smooth, waterworn surfaces of the rock were dressed by the sand blast which removed the shale and soft pits and provided a roughened surface affording better adhesion of the concrete.

A cut-off trench, 15 feet wide and 20 feet deep at the bottom, was run from end to end of the dam across the river bed and up both sides of the canyon walls in a line parallel to, and about 20 feet below the upstream face of the dam.

The excavation was carried on in three 8-hour shifts. Illumination was furnished at night by 1,000-watt electric lights suspended about 75 feet above the river bed. Much of the work, however, was of such difficult or hazardous character that it was only done in the day shift.



CUT-OFF TRENCH AND PART OF SOUTH ABUTMENT.

Thomas J. Wasser, President A. R. B. A.

Thomas J. Wasser, whose election to the presidency of the American Road Builders Association was noted last week, has had an experience of thirty-two years in general construction, railroad and highway work. In 1892, at the age of 21, he began work on macadam highway construction with B. M. & J. F. Shanley, general contractors. During the next few years he served with the Long Island Railroad, the Consolidated Traction Co. of Jersey City, the Sanford & Stillman Co., general contractors, and spent 1899 to 1903 with Robert W. Hunt & Co., engineers. In 1903 he was appointed to assume charge of preliminary work for the Hackensack bridge and Newark plank road, and later was placed in charge of this construction. He also directed the construction of the 14th St. viaduct in Hoboken.

Mr. Wasser became engineer of Hudson county in 1913 and designed and constructed most of the Newark turnpike. In 1920 he was selected by the reorganized State Highway Commission to be state highway engineer of New Jersey. In addition to membership in a number of the national engineering societies, he is president of the New Jersey Board of Professional Engineers and Surveyors.

Engineer's Plans for State Health Boards

Oklahoma—Plans are required in duplicate in general, as in the Arkansas regulations, but without specifying sizes of maps or plans; but specifications and engineer's report are to be on letter size paper, 8½x11 inches, with one-inch margins, firmly bound together at left margin. Further variations from the Arkansas regulations are as follows: For Water Supplies—Map need not show elevations of street intersections. Plan of purification works must show numbered contour lines. Quantities with unit prices are not required in the estimate. In the engineer's report discussion is asked of character of foundations for dams, loss from reservoir by seepage, and rainfall data. Also, if wells are to be used, "location of same relative to each other and to houses, sewers and other possible sources of pollution"; whether appliances to be used in purification plants are patented; same by-pass requirement as Louisiana (Public Works for May 27).

For Sewerage Systems—Profile scales suggested, vertically 10 feet to 1 inch; horizontally 100 feet to 1 inch. Plans of disposal works shall show contour lines and cross-sections of ground on which portions to be constructed are located.

Pennsylvania—The department has not adopted detailed requirements as to sizes and scales of plans, "realizing that if requirements are made very definite it may work a hardship on designing engineers by interference with their individual office standards. Our requirements, in fact, are most general, being simply that the plans be of a size which can be conveniently handled, contain a proper title, and that the drawings be of such scales as can be easily read."

Rhode Island—The board has advisory control only. It attempts to have plans filed with it, but has formulated no rules as to size or other details.

South Carolina—The Sanitary Engineering Department is new and has not yet adopted regulations as to plans, but expects to do so, asking for map, giving contours or street elevations in case of sewerage systems, lines of water mains or sewers, with size, and elevations of sewer inverts at manholes if profiles are not submitted; detail plans of all works, and complete engineer's report giving basis of design, estimates of future increase of population and any such other information as may be deemed necessary.

Tennessee—The Division of Sanitary Engineering was organized July 1, 1921, and has not yet established standard sizes or scales for maps and plans, although considering it. Its rules require, in duplicate, "complete plans and specifications," to include, for water supplies, "a description of the source of supply with information as to possible sources and extent of pollution; also of the intake, method of purification and distribution system. Plans for sewerage shall include the sewer system and disposal plant, information regarding the stream into which the effluent is to be discharged, and shall be sufficiently extensive to serve the whole community that may become tributary to the system, and also to allow for reasonable growth and development. This latter, however, does not necessarily contemplate construction of the complete system at one time." There must be submitted "results of complete chemical and bacteriological analyses, made by an analyst approved by the State Board of Health, or a sample or samples of water taken from the source or sources of supply."

Texas—*Water Supply.* There are required a general map showing the main features of the system with relation to each other and to the district served—impounding reservoirs, intakes, purification works, pumping plants, pipe lines, etc.; boundaries of watershed areas, principal sources of possible contamination of the supply. Map must not exceed 36 inches in either length or width, and have binding border of at least 2 inches at left edge.

If necessary, because of the small scale of the general map, a map to large scale is required showing all streets with accurate location of mains, fire hydrants, valves, etc., sizes and materials being definitely indicated, and any features of the system within the confines of the map being shown. Drawings are required showing details of construction at sources of supply such as dams, contour map of reservoir, area where wells are located showing location of cesspools or other possible sources of contamination and proposed protection against pollution; plan of pumping station showing kind and capacity of equipment; plans of reservoirs or tanks, and of purification works showing general layout of the various units, with detail drawings giving longitudinal and transverse sections, distributing, cleaning and draining facilities, automatic regulating devices and means for handling chemicals. "Specifications and estimates of cost must cover all items and be complete in all respects."

The engineer's report shall be on letterhead size sheets, typewritten and firmly bound together. It should discuss fully all factors bearing on the purity, impairment and purification of the supply. Headings suggested for the report are: Population studies, consumption statistics, development of supply, watersheds, lakes and large reservoirs, wells, tunnels and springs, reservoirs and basins, filtration, softening works, disinfection, pumping stations, weirs and measuring devices, by-pass arrangements, instructions for operating ("What is the period of retainer for engineering supervision of operation?"), distribution system.

Sewerage. The regulations are the same as for Arkansas, with the following exceptions: On the map, contour lines are to be at intervals of not more than 5 feet. For profiles, horizontal scale 100 feet to 1 inch; plans under profiles showing Y connections, etc., not called for. Plans for weir and disinfecting plant at disposal works not called for. In sizes of drawings suggested, a length of 60 inches is added.

PUBLIC WORKS.

Published Weekly
at 243 W. 39th St., New York, N. Y.

S. W. HUME, President J. T. MORRIS, Treasurer

Subscription Rates
United States and Possessions, Mexico and Cuba $3.00 year
All other countries..... 4.00 year
Change of Address
Subscribers are requested to notify us promptly of change of address, giving both old and new addresses.

Telephone (New York): Bryant 9591
Western Office: Monadnock Block, Chicago
A. PRESCOTT FOLWELL, Editor
FRANK W. SKINNER, Associate Editor

CONTENTS

NEGLEY RUN RELIEF SEWER. Illustrated.... 39
Blowing Fine Material from Sand..... 40
ROAD WORK IN NORTH CAROLINA MOUNTAINS. By Ray S. Blinn..... 41
PENNSYLVANIA STATE HIGHWAY EQUIPMENT 41
Rapid Erection of Trolley Bridge..... 42
HETCH HETCHY DAM EXCAVATION. Illustrated 43
Thomas J. Wasser, President A. R. B. A..... 45
ENGINEERS' PLANS FOR STATE HEALTH BOARDS 46
EDITORIAL NOTES 47
Underground Uncertainties—Increased Salaries for Sanitary Engineers
Louisville Sewerage Controversy..... 48
Manufacturing Ballast and Road Metal..... 48
Widening Rock Tunnels in Service with Sectional Shields 48
RECENT LEGAL DECISIONS..... 49
USE OF METERS AND CHECK VALVES. Table 50
WATER WORKS SERVICES. Table..... 50

Underground Uncertainties

City engineers and other public works officials do not often pay much attention to the geology of the territory in which their work is located, beyond learning whether sewer trenches will encounter rock or quicksand, or possibly whether water can be obtained by wells and at what depth. And yet such knowledge often is very desirable.

One of the most important applications of a knowledge of the strata underlying a city is the possibility thus afforded of foreseeing movements of the ground that are likely to occur if the existing equilibrium is disturbed by excavation or by imposing additional loads. A famous illustration of such disturbed equilibrium is the Culebra cut, where the engineers foresaw the great probability that the making of this cut would result in a sliding of the hill upon the sloping clay stratum, but saw no way to prevent it. The writer remembers seeing similar slides on a much smaller scale during the widening of the Erie Canal several years ago.

It is when these slides occur in a city that they become most serious. A well-known illustration is the Bigelow Boulevard in Pittsburgh, restoration work on which was described in our July 8th issue. Other streets in that city have been sliding for years; we remember seeing one thirty years ago that had a bend of several feet out of its original straight line caused by a slight slipping of the soil to a depth of twenty or thirty feet.

Another illustration of the same phenomenon is apparently taking place in Detroit. In the 1921 report of the water commissioners of that city one of the commissioners, Alex. Dow, gives reasons for believing that a blue clay know locally as "soft blue" has the faculty of yielding water and so contracting under pressure and of absorbing it and swelling when the pressure is removed, and of horizontal movement under unbalanced pressures; and that under the effects of excavating and of imposing enormous weights of buildings this clay does move horizontally and carries the ground above with it. The movements are slow and comparatively slight, but they are thought to be the cause of a movement of the survey monuments in some parts of the city from year to year, and of the breaking of water mains in some instances.

Other characteristics of this blue clay in Detroit occasionally demonstrate their importance. A contractor building a sewer in this clay placed the excavated materials on the banks of the trench and the weight of it caused the bottom of the trench to rise and the banks outside the sheathing to settle correspondingly. Unfortunately this movement was not noticed until after the sewer had been laid, and removing of the overburden and relaying was necessary. Another peculiar incident illustrated how good a conductor of vibrations this blue clay is. Two large engines resting upon this clay, when run at 145 revolutions a minute caused dangerous vibration in a bank building three blocks away but in no intervening building; and when they were speeded up a very little faster the vibrations in the bank ceased, indicating that 145 vibrations a minute happened to harmonize with the vibration period of that particular building, as well as that the clay conducted appreciable vibrations of the pumps more than a quarter of a mile.

Increased Salaries for Sanitary Engineers

The salaries paid to the engineers of the Public Health Service in the past have not been such as to retain in the service the high grade of men that the richest government in the world should have in its employ, and it must be due to other attractions of the service that such good men have been found in it for even short periods of time. Some improvement in this respect has been made possible by Congress, however, and increases in salaries became effective July 1 of this year.

Announcement has just been made of competitive examinations for assistant sanitary engineers and junior assistant sanitary engineers in the Public Health Service, at salaries of $3,225 and $2,320 respectively; the former carrying an increase of $600 and the latter of $420, both effective July 1. After twelve years of service, officers in the P. H. S. will be entitled to examination for promotion to the position of associate sanitary engineer at a minimum salary of $3,920. When reaching the age of 70 years, those who have been 15 years in the service can retire on an annuity.

Candidates for the junior position must have

passed a four-year course in engineering, or four years in extra-collegiate study and four years of practical experience in sanitary engineering; also 12 months of post-graduate experience. Those for assistant engineer must have had two years of practical experience in addition to the above. The juniors must be between 21 and 30 years of age and the assistant engineers between 23 and 32.

For young men from one to three years out of college, the above salaries will probably prove attractive if they desire the experience obtainable in the Public Health Service. How long they will be willing to stay with no prospect beyond a salary of $3,920 (less 2½ per cent. annuity assessment) is another question.

Those who desire to take the examination for these positions should apply for information to the Civil Service Commission at Washington or the nearest local secretary of the Commission.

Many other U. S. Civil service positions are not so attractive as those just mentioned. We have received notice of examinations to be held August 9 and 10 for positions of computer with the U. S. Coast and Geodetic Society, the salary for which is $1,400 a year, with $240 additional granted by Congress to provide for present high cost of living. As the calculations made in connection with the work of the Coast and Geodetic Survey require the use of the most advanced mathematical theories and processes, the salary of $1,640 a year does not seem to be one to attract many who are competent to adequately perform such service.

The Louisville Sewerage Controversy

The general features of a controversy between the contractors of Louisville, Ky., and vicinity and the sewer commissioners of that city were referred to in our issue of June 24th. We have learned that at about that date the contractors and commissioners came to an agreement, and the former have bid upon the work, having agreed to do so after recognition by the commission that the form of contract was faulty and with the understanding that the contractor could appeal to the commissioners from the decision of the engineer. In a statement explaining this decision the Kentucky Association of Highway Contractors said: "We are not confident yet that any commission or board can review a dispute without a natural and human leaning toward the views of its employees and in the present instance this can only be determined by trial. We have always had implicit confidence in the personality of the four citizens constituting the commission and in their desire to be strictly fair to the constructors." The secretary of the Kentucky Association of Highway Contractors, D. R. Lyman, in a letter sending us this information, expresses the opinion that only experience can determine whether this will prove to be a satisfactory solution.

Manufacturing Ballast and Road Metal

In Mayotown, Texas, and at New Iberia, Louisiana, the Southwest Ballast Company of Houston, Texas, are carrying on a novel process for the manufacture of ballast for railroad tracks and foundation material for highways.

The rich black gumbo and plain soil is excavated, mixed with coal and burned in the open air, producing a hard, porous, brick-like material said to be superior to sand and gravel for ballast purposes. A traveler moving on a standard gauge track is equipped with a long horizontal transverse boom from which there is handled a dragline bucket that excavates a trench about 15 feet deep depositing the material in a long bank, where it is covered, layer by layer, with coal delivered on the same track in open-top cars, unloaded from them and spread on the successive layers of muck by another traveler with transverse boom and bucket. The construction of the pile of earth and coal is continued after the first layer of coal is lighted and the burning maintained until the vegetable matter in the soil is eliminated and a hard, red, porous substance produced that is said to absorb 700 pounds of water per cubic yard. This is excavated and loaded into open-top cars by means of a third traveler equipped with transverse boom and dragline bucket. The Texas plant is said to have constructed and burned an embankment more than 1¼ miles long in about nine months.

Widening Rock Tunnels in Service with Sectional Shields

The conversion of a single track line of the Virginia Railway to double track involved the widening of five tunnels having an average length of over 11,000 feet, which was executed without materially interfering with traffic by W. W. Boxley & Co., Roanoke, Va., under the direction of engineer H. Fernstrom. The tunnels were located chiefly in shale or hard rock with slate and coal seams, and required to be widened 2 feet on one side and 18 feet on the other side and to be made higher to give a 21½-foot clearance above the rail and to accommodate a new lining 26 inches in minimum thickness, all of which involved the excavation of about 13 yards of material in the heading and 9½ yards per linear foot in the bench, amounting to a total of 250,000 yards.

During construction traffic was protected by a movable shield 60 feet long, in 4-foot sections, each consisting of two steel arch ribs of 16½-foot span over all, each supported at each end on an integral vertical steel column 14½ feet high, connected together 4 feet apart longitudinally by horizontal 4x8-inch lagging planks.

The heading, which was maintained 12 feet behind the forward end of the shield, was excavated for the full length of the tunnel and the muck loaded into narrow guage cars operated on a service track on the bench. The 12x12-inch timbering was set up as the heading advanced, and the sections of the shields were moved forward and erected by a flat car with a hand derrick.

After the heading and timbering had been completed, the bench was blasted and mucked with a steam shovel that loaded it into cars on the main line. The rock was drilled with from 4 to 6 jack hammer type drills in each heading. Progress was slow, sometimes being not more than 1 linear foot per day.

Recent Legal Decisions

ASSESSING RAILROAD PROPERTY RUNNING THROUGH STREETS

A city may charge a railroad's property which abuts, fronts or borders on the side of the street with its proportionate part of the expense of paving the street upon which such property abuts, fronts, or borders; but where a railroad whose tracks run longitudinally through the centre of a street has been assessed the cost of paving between the rails of its track and for two feet on either side, it cannot be further assessed the cost of paving the street.—Atlantic Coast Line R. Co.v. City of Gainesville, Florida, Supreme Court, 91 So. 118.

CONSTRUCTION OF STATUTE PROVIDING FOR IMPROVEMENT CONTRACTS BASED ON ESTIMATES OF CITY ENGINEERS

Section 5011 of the Nebraska Revised Statutes of 1913 requires that no improvement contract of a city of the second class shall be let for a price in excess of the city engineer's estimate. The Nebraska Supreme Court holds, State ex rel City of McCook, 187 N. W. 84, that where the engineer of such a city submits to the city council in writing an estimate of the cost of a paving improvement, based upon the unit plan, and also based upon the then existing freight rates upon the materials to be used, which estimate is supplemented by a verbal report to the city council that, if the freight rates on the materials to be used should be advanced, his estimate of the cost should be correspondingly increased, and where the city council enters into a contract with a person to do such paving for the unit prices named in such estimate, which contract contains a stipulation that, if the freight rates upon the materials used should be advanced, the cost should be correspondingly increased, and, if lowered, correspondingly decreased, such contract is a compliance with the section. This section does not require that the city council should, before letting a contract, advertise for bids and let the contract to the lowest responsible bidder on competitive bidding.

CONTRACT FOR ELECTRICITY PENDING VOTE ON PURCHASE OF PLANTS HELD VALID

The California Supreme Court holds, Los Angeles Gas & Electric Corp. v. City of Los Angeles, 205 Pac. 125, that the city did not violate Section 2 subd. 41 and section 191 of the city charter, prohibiting the sale of electricity at wholesale, by entering into a contract with light and power companies in anticipation of a purchase of their distributing systems, although the companies distributed the electricity of the city and collected the charges therefor, retaining a certain percentage of the value of the property of the companies used in the distribution of electricity as compensation, pending a vote on a bond issue to be used to purchase the companies' properties, the city receiving the surplus. Such an arrangement is not a contract required to be let only after advertisement and to the lowest bidder. The power to be supplied by the companies could not be obtained elsewhere, and was furnished by public service corporations for distribution to consumers already entitled to that service.

CONSTITUTIONAL GRANT OF POWER TO TAXPAYERS TO CREATE DEBT TO ACQUIRE PUBLIC UTILITY HELD SELF-EXECUTING

The Oklahoma Supreme Court holds, Williams v. City of Norman, 205 Pac. 144, that section 27, art. 10, of the Oklahoma Constitution, is a self-executing grant of power to the qualified property taxpaying voters of a city or town voting at an election held for that purpose, by a majority vote, to become indebted in a larger amount than that specified in sections 9 and 26, art. 10, of the Constitution, for the purpose of purchasing or constructing public utilities, or for repairing the same, to be owned exclusively by such city. Electric light plants, sewers and waterworks are held "public utilities" within the meaning of the term as used in section 27. The section is complete in itself, and needs no further legislation to put it in force. That part of the section providing that "any incorporated city or town in this state may, by a majority of the qualified property taxpaying voters of such city or town, voting at an election held for that purpose," means a majority of such voters voting, in contradistinction to "a majority of such voters in such city or town."

CONSTRUCTION OF CONTRACT TO PAY FOR PAVING MATERIAL FROM PROCEEDS OF TAX BILLS

A contract between paving contractors and parties furnishing certain paving materials, and other parties agreeing to pay for work and materials, provided that the parties furnishing the material should wait until the entire job was finished, but further provided that payment was to be made out of the proceeds of tax bills to be given the contractors, the contractors to be given a reasonable time, not exceeding six months, to sell the tax bills. The Missouri Supreme Court, Kansas City ex rel. Barrett Co. v. Spitcaufsky, 239 S. W. 808, construes this contract to mean that, if in advance of issuance of the tax bills the contractors had made such a disposition of them as showed they did not intend to pay for the material out of the proceeds of their sale, or which rendered them unable to do so, the materialman's claim would have become due on the completion of the work for the city. And if such a disposition of the tax bills had been made after their delivery, the materialman's debt would thereupon have become immediately due and payable.

POLICE POWER OF STATE TO LICENSE FUTURE USE OF WATER BY CITY

The New Jersey Court of Errors and Appeals, in State v. City of Trenton, 117 Atl. 158, has sustained, as being within the police power of the State to conserve public property, the New Jersey Act of June 17, 1907 (P. L. p. 633), imposing a reasonable license fee on cities for taking water in the future from a river in excess of the amount it was then using if such diversion shall be in excess of 100 gallons daily per capita as shown by the census of 1905.

USE OF METERS AND CHECK VALVES

Continuation, from the May 13th issue, of tables prepared from data furnished by superintendents of nearly eight hundred cities.

Municipality	Can their use be legally required?	Are check valves used at meters?	Have check valves damaged kitchen boilers or house piping?	Size of meters for ordinary residences
Pennsylvania:				
Ambler	....	yes	no	⅝"
Beaver	in case of waste	no	yes	⅝"
Bradford	....	no	.....	.....
Clearfield	yes	no	no	⅝" x ¾"
Elizabethtown	....	no	.....	⅝"
Knoxville	yes	no	.....	¾"
Lebanon	yes	large meters only	no	⅝" - ¾"
Parkesburg	Pub. Serv. Com. does	no	no	⅝"
Rankin	yes	no	.....	⅝"
Ridgway	yes	no	.....	⅝"
Sewickley	no	no	no	⅝"
Tarentum	....	no	no	⅝"
Waynesboro	yes	.....	.....	.....
West Newton	yes	no	.....	½" x ¾"
Rhode Island:				
Narragansett Pier, Wakefield, Peace Dale	....	no	no	⅝"
Phenix	no	in some cases	use safety valve	⅝" - ¾"
Providence	no	not generally	no	⅝" x ¾"
South Carolina:				
Chester	yes	no	.....	⅝"
Sumter	all metered	where large boilers	no	½" - ¾" a few 1" x 1½"
South Dakota:				
Rapid City	yes	only on steam boiler	.....	⅝"
Watertown	yes	no	.....	⅝"
Yankton	yes	on steam plants and range boilers	no	⅝"
Tennessee:				
Clarksville	yes	where serv. connected to boilers, heaters, etc.	.....	⅝" - ¾"
Covington	yes	.....	.....	.....
Dyersburg	yes	no	.....	⅛", ¾" connec'ns
Fayetteville	....	no	no	½"
Jackson	yes	yes	no	.....
Johnson City	no	no	.....	⅝"
Texas:				
Bryan	....	no	.....	⅝", ¾" connec'ns
Childress	yes	no	no	⅝" x ¾"
Clarksville	yes	no	no	⅝"
Corpus Christi	yes	no	.....	⅝" x ¾"
Del Rio	no	no	no	⅝"
Eastland	yes	no	no	¾" x ⅝"
Galveston	yes	in some cases	no	⅝"
Georgetown	yes	no	.....	⅝"
Gonzales	yes	flat rate	.....	.....
Gorman	yes	no	.....	⅝" x ¾"
Greenville	yes	all meters have cut off	check valves used on boiler conn.	⅝"
Longview	yes	no	.....	¾" x ⅝"
McKinney	city charter	no	.....	⅝"
Navasota	no	no	.....	⅝" x ⅝"
Orange	yes	no	.....	⅝"
Weatherford	....	no	.....	⅝"
Utah:				
Brigham	city has jurisdic'n	yes	no	⅝"
Vermont:				
Bennington	no	no	.....	⅝"
Brattleboro	at option of Co.	yes	no	⅝"
Washington:				
Aberdeen	yes	yes	no	⅝" and ¾"
Anacortes	yes	yes	no	⅝", ½" spuds
Auburn	yes	where necessary	no	⅝" x ¾"
Bellingham	no	yes	no	¾"
Cle Elum	rests with council	no	no	½" - ⅝"
Dayton	yes	no	.....	⅝", ½" or ¾" connections
Ellensburg	no	no	.....	.....
Hoquiam	yes	no	very little	⅝", ¾" connec'ns
Port Angeles	no	no	.....	⅝"
Snohomish	yes	where hot water can come back	no	¾"
Tacoma	....	only where trouble from boiler water	no	⅝" and ¾"
Walla Walla	yes	.....	no	¾", ⅝" connec'ns

Table III—Water Works Service

Municipality.	Private (P.) or municipal (M) plant.	Services laid preparatory to paving, before needed for use. Are they required by city?	Kind of pipe specified.	Depth specified.	Trouble experienced with them after laying.
Arizona:					
Clifton	P.	no pav.	....	2 ft.	.....
Douglas	M.	yes	l.	2½-3 ft.	none
Glendale	M.	no	not specified	deep enough to clear plow	none
Nogales	M.	no	....	....	.....
Prescott	M.	yes	¾"	2 ft.	none
Tucson	M.	yes	l.	2 ft.	one or 2 sand holes
Idaho—Continued					
Preston	M.	yes	g., l. gooseneck	4 ft.	none
Weiser	M.	yes	l.	42"	none
Illinois:					
Hinsdale	M.	yes	l.	4 ft.	found stopped up
White Hall	M.	no pav.	....	30 in.	.....

Arkansas:					
Helena	P.	yes	l.	1 ft. below base of pro. pave.	ll., only where gas-con. ket depreciates and blows out on nut and tail piece connection on wiped joint connections
Russellville	P.	no	....	....	.....
California:					
Anaheim	M.	yes	g.	24-30 in.	.....
Benecla	P.	no	none	no spec.	none
Burbank	M.	no	....	18 in.	.....
Calexico	M.	yes	none	3 ft.	none
Daly City	M.	yes	¾" pipe & curb cock	2 ft.	none
Dinuba	M.	no	....	....	.....
El Centro	M.	yes	l., cross fitting	2 ft.	none
Fort Bragg	...	no	...	no spec.	.....
Fullerton	M.	yes	l.	18 in.-2 ft.	rusting out
Monterey Pacific Grove Carmel Pebble Beech	P.	no	....	....	.....
National City	P.	optional with co.	....	1-2 ft.	.....
Needles	P.	no	....	....	.....
Oxnard	M.	yes	none	2 ft.	none
Palo Alto	M.	practice abandoned	3¼" wi.	18-24"	idle serv. deteriorates more quickly than used
Red Bluff	M.	yes	g., wi.	2 ft.	none
Redding	P.	no	....	2 ft.	none
Salinas	P.	no	no spec.	no spec.	on cert. st. 12 serv. leaked and were cut off before being used
San Fernando	M.	usually	¾" wi.	2 ft. 6 in.	rust after sev. yrs.
Santa Maria	M	yes	¾" wi.	2 ft.	no more than ex-
Santa Paula	P.	no	none	18-30"	few caused by defective pipe
So. Pasadena	P. & M.	yes	¾" g.	30 in.	none
Colorado:					
Brighton	M.	yes	l.	5 ft.	none
Delta	M.	no pav.	....	3½ ft.	.....
Denver	M.	no	....	5 ft.	.....
Montrose	M.	no	i.	3 ft. 6 in.	none
Sterling	M.	yes	l.	3½ ft.	none
Connecticut:					
New Brit in	M.	no	....	....	.....
New London	M.	sometime	l., ci or br ss	4½ ft.	none
Florida:					
De Land	..	yes	l.	2 ft.	none
Ft. Myers	M.	yes	2 ft. l., rest wi.	2 ft.	none
Lakeland	M.	no	....	12"-18"	none
Quincy	M	yes	g., l gooseneck	2 ft.	rust and corrode
Georgia:					
Cedartown	M.	no	....	18"	none
Newnan	M.	yes	non., use g.	12"-18"	none
Idaho:					
Blackfoot	M.	no	....	4 ft.	none
Burley	M.	no	....	3 ft.	none
Caldwell	M.	yes	g.	3 ft.	none
Coeur d'Alene	P.	no	¾"	4 ft.	occasional freeze up
Lewiston	M.	yes	gwi.	4½ ft.	l. gooseneck bursting because of poor workmanship)
Montpelier	M.	yes	¾" residence up to 2"	4½ ft.	some from freezing
Indiana:					
Franklin	P.	no	wi. generally used	30 in.	.....
Portland	M.	yes	l.	3 ft.	none
Princeton	P.	yes	no spec.	3 ft.	none
Richmond	P.	yes	l.	4½ ft.	.....
Rushville	M.	yes	ll.	3 ft	very little
Seymour	P.	...	....	3½ ft.	none from frost
Shelbyville	P.	no	....	....	.....
Iowa:					
Albia	M.	yes	l.	4-4½ ft.	2 cases of freezing
Cedar Falls	M.	yes	wi.	5½ ft.	.....
Charles City	M.	yes	l.	6 ft.	seldom
Cherokee	M.	yes	l.	6 ft.	practically none
Nevada		yes	¾" l.	5 ft.	none
Newton	M.	yes	l.	4½ ft.	none
Oskaloosa	P.	no	l.	4 ft.	none
Winterset		yes	gs.	4 ft.	rusting and splitting in weld
Kansas:					
Augusta	M.	yes	l.	30 in.	none
Baxter Springs	M.	yes	l. ⅝", ¾", 1"	24-30 in.	freeze once in 10 yrs.
Concordia	M.	to lot line	¾"	3½ ft.	none
Council Grove	M.	no	..	3 ft.	none
Holton	M.	only when pavt. goes to sidewalk	l.	3 ft.	none
Junction City	M.	no	....	4 ft.	.....
Manhattan	M.	yes	l. or wi.	3 ft.	very little
Pratt	M.	yes	....	3 ft.	none
Kentucky:					
Georgetown	P.	no	....	....	.....
Hickman	P.	...	none	2 ft.	had to relay some
Hopkinsville	P.	no	....	....	.....
Maysville	P.	...	....	30"	none
Paris	P.	yes	¾"-1"	3 ft.	none
Maine:					
Calais	P.	no	....	4½-5 ft.	none
Gardiner	water dist.	no	....	5 ft.	.....
Rockland	...	no	....	....	.....
Rumford	M.	no	....	....	.....
Maryland					
Baltimore	M	no	....	....	.....
Massachusetts:					
Adams	...	if necessary	¾"	5½ ft.	none
Dalton	M.	outside of sidewalk	g.	5 ft.	[illegible]
E. Bridgewater	M.	...	....	....	[illegible]
Falmouth	M.	no	....	....	[illegible]
Fitchburg	M.	no	....	6 ft.	[illegible]
Lynn	M.	no	....	....	[illegible]
Millbury	P.	no	....	....	[illegible]
Shrewsbury	M.	no	....	5 ft.	[illegible]
Michigan:					
Coldwater	...	yes	l.	5 ft.	none
Grand Rapids	M.	yes	l. up to 1"	5½ ft.	none
Hancock	M.	no	....	4' 6"	frost when ground not covered enough with snow
Iron Mountain	P.	no	....	7 ft.	.....
Royal Oak	M.	yes	gwl.	4 ft.	none
St. Joseph	M.	yes	l.	3½ ft.	only where elec. cars
Minnesota:					
Alexandria	M.	yes	l. & wi.	8 ft.	none
Fairmont	M.	yes	l.	4-5 ft.	none
Litchfield	M.	no	l.	7' 6"	none
Moorhead	M.	yes	l.	6 ft.	none
New Ulm	M.	yes	⅝" l.	8 ft.	none
St. Peter	M.	no	....	....	.....

(To be continued)

NEWS OF THE SOCIETIES

CALENDAR

July 18, 19, 20—STEEL METAL CONTRACTORS' ASSOCIATION OF OHIO. Annual convention. Zanesville, Ohio. L. W. Henslee, chairman, convention committee, 623 Putnam Ave., Zanesville, Ohio.

July 19-21—MICHIGAN STATE ASSOCIATION, NATIONAL ASSOCIATION STATIONARY ENGINEERS. Annual convention. Masonic Temple, Kalamazoo, Mich. Secretary, E. C. Smith, 208 W. Vine St., Kalamazoo, Mich.

July 27-28—SHEET METAL CONTRACTORS' ASSOCIATION OF PENNSYLVANIA. Convention. Hotel Lawrence, Erie, Pa. Secretary, W. F. Angermeyer, 714 Homewood Ave., Pittsburgh, Pa.

July 26-28—WISCONSIN STATE ASSOCIATION, NATIONAL ASSOCIATION OF STATIONARY ENGINEERS. Convention and mechanical exhibit. Capitol Building, Madison, Wis. Chairman, convention committee, J. J. Novotny, 2133 Fox Ave., Madison, Wis.

Aug. 15-17—LEAGUE OF IOWA MUNICIPALITIES. Annual meeting. Secretary, F. G. Pierce, Marshalltown, Ia.

Aug. 15-18—INTERNATIONAL ASSOCIATION OF FIRE ENGINEERS. Fiftieth convention. Municipal Auditorium, San Francisco, Cal. Secretary, James J. Mucahey, Chief, Yonkers, N. Y., Fire Dept.

Aug. 28-Sept. 2—NATIONAL SAFETY CONGRESS. Detroit, Mich.

Sept. 11-15—ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS. New Auditorium, Cleveland, Ohio.

Sept. 12-15—NEW ENGLAND WATER WORKS ASSOCIATION. 41st annual convention. New Bedford, Mass. Secretary, Frank J. Gifford, Tremont Temple, Boston, Mass.

Sept. 14-16—AMERICAN ASSOCIATION OF PORT AUTHORITIES. Convention at Toronto. Secretary, M. P. Fennell, Jr., Montreal.

Sept. 25-28—SOUTHWEST WATER WORKS ASSOCIATION. Annual convention. Hot Springs, Ark.

Oct. 1-6—AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS. Annual convention. Cleveland, Ohio.

Oct. 16-19 — AMERICAN PUBLIC HEALTH ASSOCIATION. Annual meeting. Cleveland, Ohio.

Nov. 15-16—NATIONAL INDUSTRIAL LEAGUE. Annual meeting. New York City. Secretary, J. H. Beck, Chicago.

Dec. 7-13—NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING. New York City.

PROVIDENCE ENGINEERING SOCIETY

At a recent meeting the following officers were elected: President, Professor J. A. Hall; Vice-Presidents F. C. Freeman, R. W. Eaton, F. W. Bliss; Secretary, J. T. Barnicoat; Treasurer, A. E. Thomley; Librarian, E. E. Baker; Chairman of Publication Committee, F. R. Inman; Councillors, J. R. K. Lyons, W. C. Slade, E. E. Nelson and George Squibbs.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION

Several papers of interest were read at the annual convention of this cociety held at Urbana, Illinois, June 20th. Some of these were: "Cultural Element in Engineering Education," by W. H. Rayner of the University of Illinois; "Some Problems in Engineering Education," by J. H. Dunlap of the Iowa State University; "Teaching," by Charles E. Chadsey of the University of Illinois.

The following were elected to office: President, Charles F. Scott, of Yale University; Vice-Presidents, D. S. Kimball of Cornell and F. G. Higbie of Iowa; Council Members, M. W. Alexander, National Industrial Conference Board; Edward Bennett of Wisconsin, H. S. Evans of Colorado, E. A. Hitchcock of Ohio, H. J. Hughes of Harvard, C. E. Magnussen of Washington and G. C. Shadd of Kansas State.

AMERICAN SOCIETY FOR TESTING MATERIALS

The opening session of the annual meeting at Atlantic City was devoted mainly to the discussion of the corrosion of iron and steel. A paper on that subject was presented by Professor W. D. Bancroft.

The results of the election were as follows: President, Dr. George K. Burgess, chief of the Division of Metallurgy of the U. S. Bureau of Standards; Vice-President, Dr. William H. Walker; Directors, D. M. Buck, Dr. W. K. Hatt, W. M. Corse and J. R. Onderdonk.

WESTERN SOCIETY OF ENGINEERS

The annual meeting and dinner of this society held in Chicago was addressed by C. S. Richards, former dean of the college of engineering, University of Illinois, who spoke on the subject of training of engineers.

Officers for the new year were elected as follows. President, J. L. Hecht; Vice-Presidents, Frank F. Fowle, Charles A. Morse and E. T. Howson; Secretary, Edgar S. Nethercut; chairman of the several sections: bridge and structural, C. L. Post; electrical, F. E. Goodnow; gas, H. E. Bates; hydraulic, sanitary and municipal, P. E. Green; mechanical, Horace Carpenter; railway, H. G. Clark; telephone, telegraph and radio, Burke Smith.

ASSOCIATED GENERAL CONTRACTORS OF AMERICA

At the Executive Board meeting, June 21, the application for a State Branch from the general contractors of North Carolina, with 35 charter members, was favorably voted on. The special committee on Concrete Specifications reported unfavorably on the suggestion of the chairman of the Joint Committee on Specifications for Concrete and Reinforced Concrete that tests should be made in various parts of the country by the contractors, and their opinion was sustained by the Executive oBard. The committee was continued and authorized to prepare specifications for concrete and reinforced concrete.

ASPHALT ASSOCIATION

At its recent annual convention in New York the following were elected to office: President, Joseph R. Draney, U. S. Asphalt Refining Co., New York; Vice-President, F. P. Allen, Standard Oil Co. of Indiana, Chicago, Illinois; Treasurer, Herbert Spencer, Standard Oil Co. of New Jersey, New York; Secretary, J. E. Pennybacker, New York.

Resolutions urging lower freight rates on road materials and equipment, increases in compensation for competent engineers, and open competition between all types of paving construction. A protest was made against the proposed limitation of Federal Aid funds for highway construction

PORT AUTHORITIES

The convention of the American Association of Port Authorities will be held in Toronto, Canada, on September 14th, 15th and 16th and will be followed by an excursion down the St. Lawrence River through the Thousand Islands to Montreal, where an opportunity will be given to see the terminal facilities of this great port, after which the excursion will be continued down the river to Quebec, where the Harbor Commission will receive the members of the association and their guests and exhibit their harbor and its terminal facilities.

PERSONALS

Foreman, Charles S., has been promoted from assistant chief engineer of the Kansas City water department to the position of superintendent.

Wertz, Leroy F., formerly assistant chief engineer of maintenance of the State Highway Department of Indiana, is now chief of the division of auditing and succeeds John D. Williams, now director of the State Highway Commission.

Putnam, George W., has been appointed state sanitary engineer of Missouri.

Dowler, Charles H., city manager of Wheeling, W. Va., will resign from that office to take the position of member of the West Virginia State Road Commission.

Charron, Henry S., succeeds J. Frank Kidder as superintendent of the water department at Burlington, Vt.

Applegate, Lloyd, of Youngston, Ohio, has been elected village engineer of McDonald, Ohio.

Allen, Frank R., has been appointed city engineer of Pine Bluff, Ark., to succeed J. H. Guest, resigned.

Ullius, F. W., Jr., who has been village engineer of Shorewood, Wis., for nine years, has been appointed city planning engineer of Milwaukee, Wis., to succeed R. E. Stoelting.

New Appliances

Describing New Machinery, Apparatus, Materials and Methods and Recent Interesting Installations

JARMIN ROAD FIXER

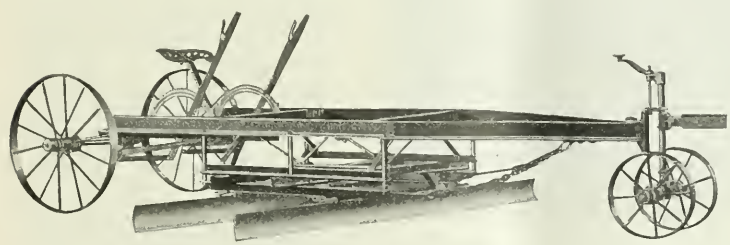
The Jarmin Road Fixer, which is manufactured by the Glide Road Machinery Company, essentially different from all other road surfacing equipment, is termed the "missing link between the road drag and the road grader." It dispenses with the road drag and does all the work that a two-man grader will do in maintaining a road. It shaves off the high places and fills in the low places, cleans ditches and moves material toward the center of the road. Its work is superior on account of the long wheel base and the two cutting edges that travel on a practically horizontal line.

The principal features of the machine are the 156-inch wheel base and the two 8-foot blades that are positively carried by the frame in such a way as to allow no up-and-down movement between the blades and frame, thus eliminating the choppy surface that is caused by blade jumping.

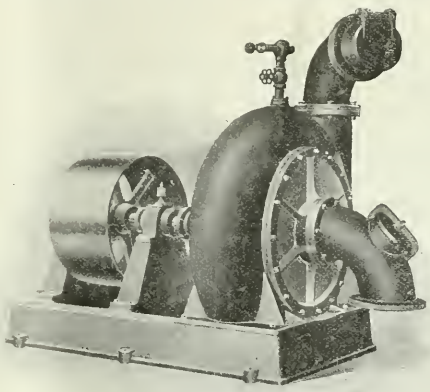
The long wheel base enables the blades to cut off the high places in a wavy road surface and to fill in the low places. The blades can be set to any angle so as to move the material either to the right or to the left. The blades are so connected that the rear blade follows directly behind the front blade. The front blade has a tendency to drag in the coarser material and the rear blade to smooth it over with finer material.

The rear end of the machine is carried by two wheels mounted on separate axles controlled by a hand lever which allows the operator to lift one side of the blade and lower the other as desired, thus maintaining the crown of the road regardless of width. The rear wheels, 36 inches in diameter, have a 3-inch concave tire and a 56-inch tread, while the small front wheels, with a 20-inch tread, clear the underside of the frame. The machine weighs 1,085 pounds, can be operated with a team, a 1-ton truck, or a light tractor and can be operated by the same man that drives the team.

One purchaser writes that he has found nothing to equal them in maintaining finished roads. Another has found them satisfactory in every class of road from macadam to heavy adobe and on dirt roads that are rutted and full of holes.



THE GLIDE ROAD MACHINERY COMPANY'S JARMIN ROAD FIXER.



HODGE, THOMAS & SHEFFER'S SAND AND GRAVEL PUMPS.

SAND AND GRAVEL PUMPS

The centrifugal pumps manufactured by Hodge, Thomas & Sheffer, are of simple, sturdy construction especially recommended for dredging sand and gravel for construction purposes for which they are claimed to be so well adapted that they are listed in the manufacturer's bulletin as "The Contractor's Friend," and offered to make dirty gravel clean and to make fine gravel coarse.

The pumps are made for extra heavy duty with a semi-steel cast pump shell, reinforced in places that are subject to the most wear. The piston is also of heavy construction lined with steel plates that can be easily removed.

The pump is manufactured in four sizes with shipping weights of 1,095, 2,475, 4,200, and 5,475 pounds respectively with discharge pipes 4, 6, 8, and 10 inches in diameter and having rated capacities of 14, 30, 60, and 90 cubic yards of material per hour when carrying a 10 per cent. proportion of solid material. They require 4, 8, 16, and 25 hp. for each ten feet that the water is elevated and will pass stones with diameters of 2, 4½, 6, and 8 inches in diameter for the respective sizes.

If water is to be raised only 5 feet the revolutions per minute should be 285, 214, 186, and 168 for the respective sizes, increasing 1,274, 955, 819, and 762 when water is raised to a height of 100 feet.

A portable 6-inch pump installed in a pit north of Auburn, Indiana, produced 10,158 yards of mixed sand and gravel for road construction, having 60 per cent. sand, at a cost of 46½ cents per yard for materials used. The entire plant ready for use cost about $1,250 and was operated by a traction engine. It can handle from 250 to 350 yards of sand and gravel in ten hours. It can be belt driven from a steam or gasoline engine, and is convenient, economical and efficient.

INDUSTRIAL NOTES

The Pittsburgh Testing Laboratory has opened a sales and inspection bureau in the Railway Exchange Building, St. Louis, Missouri. Colonel N. C. Hoyles has been appointed district manager.

The Woodward-Republic Construction Co., Cleveland, Ohio, has been organized to do general engineering and construction work.

Langthorn & Smith, Inc., New York City engineers and builders, announce their incorporation to carry on the building work formerly conducted by C. H. Smith.

Orton & Steinbrenner Co., manufacturer of locomotive cranes, grab buckets and coal crushers, in order to secure larger space, has moved its offices from the 11th to the 19th floor of the Transportation Building, 608 South Dearborn Street, Chicago, Illinois.

The Strauss Bascule Bridge Co. announces the opening of a new eastern office to take the place of the New York office, at 603 Albee Building, Washington, D. C. J. C. Eversman will have charge of the office.

MACHINE TRENCHING RECORDS

Satisfactory records of trench excavating with the standard Pawling & Harnischfeger Ladder Type Trencher have been made by Thomas Haverty & Co., Los Angeles, who, with the standard machine, cut 552 linear feet of trench 30 inches wide and from 9 to 12 feet in depth in 4 hours, working at an 8 per cent. grade.

Although this machine was not rated for digging below 8 feet depth the same contractors successfully used it in excavating a 30-inch trench to a depth of 30 feet at one operation, an achievement which was accomplished by the addition of an extension boom not recommended by the manufacturer.

These trenches have been dug by the aid of the machine at the rate of 45 to 50 linear feet per hour, with a record of 720 feet in one day, working up a 5 per cent. grade.

ROOT SPRING SCRAPER SERVICE

The engineer manager and the county engineer of Ottowa County, Michigan, report that a Root Spring Scraper, installed last fall, on trunk line 16, between Grand Haven and Grand Rapids, satisfactorily replaced four or five teams and that during the present year the same scraper will be used on a 2-ton Nash quad-truck on a gravel road 19 miles long between Jenison and Zealand, where there is a traffic of 1,000 vehicles daily and it is expected that the use of the scraper will reduce the number of patrol men previously required.

In his report to the Board of County Road Commissioners, County Engineer Allen M. Williams stated his opinion that the new Root Spring Scraper installed on one of the Nash quad-trucks gives a superior quality of work and that the action of the springs on the scraper counteracts the vibration of the truck, leaving a small and even swath. The best results are attained with a speed of 8 to 12 miles an hour, the average daily mileage is from 70 to 90 miles, equalling one-half the distance of road maintained.

Assuming that the scraper replaces 6 teams at a total cost, including deterioration of $30.30, the cost of the scraper including fuel, driver and deterioration is $13.21, showing a saving of $17.09 per day or if used during seven months of the year would amount to $3,110.38 per truck.

The scrapers are also efficient for removing snowfall up to 12 inches in depth.

For the construction of nearly seven miles of brick pavement on a concrete base, between Putnamville and Meridan, Ind., the Carpenter Construction Co., contractor, has ordered Koppel riveted track with slip end ties and Koppel batch box cars with Koppel continuous draft gear to take strain away from end and side sills. Koppel wooden drop bottom batch boxes will handle the aggregate to the paver.

PAWLING & HARNISCHFEGER TRENCHER EXCAVATING 550 FEET OF DEEP TRENCH IN FOUR HOURS.

TRADE PUBLICATIONS

THE UNA-FLOW STEAM ENGINE

By Prof. Dr.-Ing. h. c. J. Stumpf. 7½ x10½ inches, 319 pages, cloth covers. illustrated with numerous detail diagrams and half-tones. Translated by the Stumpf Una-Flow Engine Company, Inc., 401 S. A. & K. Building, Syracuse, N. Y.

In the opening chapters of the book the different losses of the steam engine are investigated. The causes and effects are defined, as well as the relations between them, and the manner is pointed out in which the minimum value of each loss is obtainable. After considering all of the seven different losses occurring in a steam engine, the question is asked as to how a steam engine must be designed in order to have a minimum total of all the seven losses. In answer to this query two different designs are presented, one being a stationary Una-Flow engine with single-beat valves for condensing operation, and the other a Una-Flow locomotive, equipped with single-beat valves.

Both types of engines were developed during the year 1920. Lower steam consumption figures than those given by the best multi-stage engines are obtainable with these types for both saturated and superheated steam. The experience gained with Una-Flow engines in widely different fields and under the most varying conditions was utilized in the design of these engines.

A number of chapters are devoted to the description of this development in all its phases.

The novelty in this case is the single-beat valve, which has so far been used only in internal combustion engine practice. All previous attempts to apply it to steam engines have miscarried. The application of this type of valve to the Una-Flow engine represents the keystone in the development of the latter.

HANDBOOK OF PIPE.

Issued by the East Jersey Pipe Co. A manual providing tables, charts and other useful information relating to the carrying of fluids and gases by pipes; pipe installation and test data having to do with large diameter steel pipes together with the story of lock bar and riveted steel pipes, from 20 to 72 inches in diameter, with special couplings, joints, riveted tees, reducers and specials and a complete line of fittings. Half tone illustrations of details and installations, numerous convenient tables. Principal features discussed include material specifications, fabrications, joints, fittings, tests, working brushes, pipe data, corrosion, and electrolosis, cost, failure of pipe lines, hydraulics, weir measurements, water power, water supply, testing lines, installation of pipe lines, distribution of water, water consumption, and formula.

PUBLIC WORKS.

CITY COUNTY STATE

A Combination of "MUNICIPAL JOURNAL" and "CONTRACTING"

Vol. 53 July 22, 1922 No. 4

Resurfacing Old Pavements

Methods employed by several score of cities in resurfacing old concrete, brick and other kinds of pavement, as reported by city engineers.

Although some pavements are more durable than others, no type or kind of pavement is everlasting, but wear begins with the first traffic and continues unceasingly thereafter. Some pavements it is possible to maintain continuously, these including both waterbound and bituminous bound macadam, bituminous concrete, sheet asphalt and the various other bituminous pavements. Pavements made of separate large units, such as brick, stone and wood block, and concrete pavements can be repaired only at longer intervals if the same material is used, although in some cases incipient holes are filled with bituminous material. With almost any pavement the time will finally come when further repairs will not be economical, but the whole pavement should either be replaced or should be covered with a new wearing surface.

The following article is prepared from information furnished by several hundred city engineers describing the materials and methods employed by them in resurfacing or renewing the surface of pavements in their respective cities. So far as possible the different methods are arranged according to the materials constituting the old pavement, while the cities and states cited are given in their alphabetical order.

The information was furnished this year and in most cases applies to the practice followed in the year 1921.

OLD BRICK PAVEMENTS

In Bisbee, Ariz., the worn out brick is removed and a concrete surface is placed upon the old concrete base.

In New Haven, Conn., a new wearing surface of 1½-inch binder and 1½-inch top is ordinarily laid directly on the old brick. If the brick are removed and the old concrete base is used, the additional thickness is supplied with an extra thickness of binder and the top or wearing surface may be increased to 2 inches.

The city engineer of Meriden, Conn., C. Perry Pratt, says: "I would not recommend resurfacing of stone block, brick or concrete. If there is a concrete base of sufficient thickness I would prefer to pull out the old brick or stone block and relay on old foundation. A resurfacing job on either of the above types of pavement in order to give good service must be an inch or two thick and such resurfacing makes too shallow gutters. In the case of a concrete pavement I think that the only thing to do is to repair it as long as it will stand repairing and then replace it."

Bloomington, Ill., expects this year to resurface with one-inch binder and two-inch wearing surface of asphaltic concrete.

In Chicago, Ill., the interstices of the pavement are cleaned out and 1½-inch of binder is laid and on this 1½-inch of sheet asphalt or asphaltic concrete.

Danville, Ill., has resurfaced some brick streets by removing the old wearing course and laying 3-inch vertical fibre brick on a 2-inch sand-cement bed, using asphaltic filler. This cost $2.75 per square yard including the removal of the old brick. In other cases the old brick surface has been covered with a 2-inch top of Bermudez sheet asphalt on a one-inch binder, this costing $2.47 per square yard.

In Peoria, Ill., the old brick surface is well swept and washed, if necessary, and then painted with a thin coat of hot asphaltic cement. A binder course is then rolled into all depressions until there is a minimum thickness of one inch over the entire surface. A 2-inch course of sheet asphalt is then applied in the usual way. Before applying the binder the old brick surface is taken up and relaid where necessary along the edges of car tracks, other improvements, etc., to permit the added thickness of the new pavement.

Covington, Ind., has resurfaced old brick pavement by removing the brick and replacing with concrete.

Gary, Ind., resurfaces old brick with sheet asphalt.

Lafayette, Ind., has resurfaced brick streets by renewing the brick.

In Logansport, Ind., depressions in the brick pavement are filled with binder course and then the whole pavement is covered with a wearing course of sheet asphalt which is tapered off at the car track

rails, sewer castings, etc. A portable plant is used in this work.

Cedar Rapids, Ia., uses asphaltic concrete for resurfacing brick and concrete pavements.

Fort Dodge, Ia., cleans off the old brick surface and covers with one-inch of binder and 2 inches of sheet asphalt.

In Des Moines, Ia., brick surface is thoroughly cleaned by flushing and deep depressions are leveled up either by filling with used brick or by building up with asphaltic binder. The surface is then treated with a sprinkle coat of asphaltic cement and one-inch binder course is applied, followed by 1½ inches of sheet asphalt or 2 inches of asphaltic concrete. In 1921 an old 2-course brick pavement was treated by residents under private contract as follows: The surface was thoroughly cleaned and low places leveled up by filling with hard rock and Tarvia X. Tarvia B was spread hot with an oil spreader at about ½ gallon per square yard. A heavy course of gravel retained on a 1-inch screen and passing a ½-inch screen was applied and rolled with a 10-ton roller. A second coat of hot Tarvia B was applied at about ½ gallon per square yard and a second coat of the same gravel sufficiently thick to cover, and traffic was admitted immediately. This surface wears almost to the appearance of asphaltic concrete, the loose gravel being held by the Tarvia and filling up by bleeding from below. Some spots will have to be re-treated and some maintenance done when warm weather permits, as the workmen were not experienced and did not get a uniform distribution of pitch. When laid in warm weather and given some attention to see that all spots are uniformly treated, the results are very acceptable. The complete cost was less than 60 cents per square yard. The street carries a very heavy automobile traffic and much heavy hauling and traverses the highest value property in the city. The width of the roadway is about 40 feet and the length of the work about one mile.

Ottumwa, Ia., has practiced taking up the old brick and replacing with new brick or creosoted wood block on the old base. They may resurface some old brick pavement this year with asphaltic concrete.

Manhattan, Kans., covers the brick with asphalt spread with a squeegee.

Parsons, Kan., resurfaces old brick with asphalt concrete, Topeka mixture, in about the following proportions: Chatts, 275 pounds; river sand, 375 pounds; bank sand, 200 pounds; stone dust, 80 pounds; asphalt cement, 80 pounds. Texaco No. 45 was used in all this work.

In Wichita, Kans., the old brick surface is leveled up with concrete and binder and is then surfaced with standard sheet asphalt or asphaltic concrete.

Ashland, Ky., resurfaces brick pavements with new brick.

Ludlow, Ky., last year resurfaced 12,000 yards of old brick street by removing the brick and replacing it with asphalt macadam.

In Baltimore, Md., badly spalled areas of brick pavement have been given a squeegee coat of asphalt road binder applied hot and covered with pea gravel or stone chips.

Frederick, Md., resurfaces old brick streets by turning the brick and relaying them.

Hagerstown, Md., has surfaced old brick pavements with asphalt macadam, which has not proved very successful.

Battle Creek, Mich., resurfaces with sheet asphalt laid in the regular manner.

Grand Rapids, Mich, removes the old brick from the concrete foundation and relays with new brick.

Kalamazoo, Mich., lowers the brick along the curb and around the manholes and resurfaces with sheet asphalt.

Midland and Muskegon, Mich., resurface with sheet asphalt top.

In Saginaw, Mich., brick surface is thoroughly cleaned with steel brushes and is then swept with fibre brushes and is finally flushed and scoured with water under 40 to 50 pounds pressure using a fire hose. The work is done only during dry, hot weather. All depressions are then filled with a close binder thoroughly rolled or tamped in placed to bring the surface approximately parallel to the required contour. This is followed as closely as possible with the laying of a close binder course and on this a top course of sheet asphalt. Extreme care is taken that the brick surface is sufficiently rough. If there are any smooth places the bricks are chipped and the surface roughened so as to insure a bond.

Rochester, Minn., cleans the old surface, fills the depressions and applies a 2-inch bitulithic wearing surface.

In St. Paul, Minn., the old surface is cleaned, leveled up with binder not to exceed 3 inches in depth, and then covered with a wearing surface of either sheet asphalt or asphalt concrete.

Joplin, Mo., resurfaces old brick pavements by pouring from 1/2 to 3/4 of a gallon of asphalt or tar product on the cleaned surface, covering with Joplin chats and rolling with a 7-ton roller.

Sedalia, Mo., expects to resurface about 30,000 square yards of rough brick pavement with a mat coat of broken stone and asphalt, the wearing surface to be from 1/2 inch to 3/4 inch thick after rolling. The specifications provide for thoroughly cleaning the old pavement, bringing up depressions that exceed 3/4 of an inch deep with asphaltic macadam, then applying a priming coat of asphaltic oil followed by a coat of liquid asphalt at the rate of about 1/2 gallon per square yard. This is followed immediately by spreading a layer of crushed limestone of a size between 1/4 and 3/4 inch to uniform depth of a half an inch, following which the roadway is thoroughly rolled with a 5-ton tandem roller. After rolling, the roadway is swept clean of all excess stone and another application of liquid asphalt is made at a rate of from 1/4 to 1/2 gallon per yard, which is covered with limestone chats ranging up to 1/2 inch and the pavement is again thoroughly rolled and is then ready for traffic.

Kansas City, Mo., thoroughly cleans the surface and joints of old brick pavement by heating and sweeping, and then makes a very light application of A. C. along the joints and surfaces with 2 inches of asphaltic concrete placed hot and thoroughly rolled.

Springfield, Mo., apparently uses practically the same method as Sedalia.

St. Louis surfaces old brick pavement with sheet asphalt or bitulithic.

Lincoln, Nebr., resurfaces with 2 inches of asphaltic concrete.

Omaha, Nebr., uses either asphaltic concrete or sheet asphalt with binder.

Newark, N. J., for several years has resurfaced brick streets with a coat of asphalt approximately one inch thick.

Endicott, N. Y., replaces old brick with new.

Middletown, N. Y., has resurfaced old brick with a 2-inch warrenite pavement at $2.70 per square yard.

Norwich, N. Y., resurfaces brick and other pavements with an application of No. 1 stone and Tarvia A.

Olean, N. Y., has done some brick patching using Tarvia K. P. and crushed stone for filling holes and depressions. Where these are of considerable area or depth, new brick is used.

Poughkeepsie, N. Y., covers the old surface with a light coat of asphalt macadam.

In Rochester, N. Y., the contractor is required to take up and remove all old brick which the engineer believes should be removed, and these are replaced with sufficient Class C concrete to bring the foundation up to the required height to permit a binder course of one-inch and a wearing surface of 2 inches of asphalt to be laid thereon. The part of the old pavement not disturbed is thoroughly cleaned by brooming and the joints raked out and cleaned of all organic matter.

In Schenectady, N. Y., the old brick are removed, an additional amount of cement concrete is applied to the base and a top of stone-filled asphalt is then applied, using a binder course, where necessary.

In Troy, N. Y., 11,000 square yards of bitulithic was laid last year over old brick pavements.

In Waverly, N. Y., old brick pavements are thoroughly washed, dried and swept clean and Tarvia X is then applied, about 3/4 of a gallon to the square yard, with a force distributor. Following this, a lighter layer of pea-sized screened gravel is evenly scattered over the entire surface.

The city manager of Greensboro, N. C., P. C. Painter, writes that he has found that old brick pavements can best be resurfaced with about 2 inches of bituminous concrete, which is very satisfactory where there are no street car tracks on the street.

Akron, Ohio, provides brick gutters (presumably new ones) 3 to 5 feet wide, the remaining surface is scrubbed and the soft places dug out and replaced with concrete. A binder course is then laid on the old pavement, which is first roughened where smooth, and is followed with 1½-inch asphalt wearing surface.

Bellaire, Ohio, sweeps with steel brooms and flushes with water and sweeps again if necessary; fills depressions with concrete, lays a one-inch binder course and a 1½-inch wearing surface of sheet asphalt.

In Bucyrus, Ohio, the surface is cleaned thoroughly, low spots filled with Tarvia K. P. mixture, the street is then sprinkled with tar or asphalt and covered with bird's eye gravel. "This gives a mat which is smooth, resilient and durable,' says F. L. Niederheiser, city engineer.

In Canton, Ohio, old brick pavements 15 to 32 years old are covered with one-inch to 1½-inch binder and 1½ to 2-inch sheet asphalt surface, holes being first filled with bricks or cement. Gutters from 27 inches to 54 inches wide are raised to be level with the new surface.

In Cleveland, Ohio, the surface is thoroughly cleaned and large depressions filled with portland cement concrete. At intersections and some other places where a higher elevation is undesirable, the brick is relaid at a lower grade. On car track streets the pavement along the rail is relaid far enough from the rail to allow a crown to be worked out in the asphalt top. New gutter grades are calculated and marked on the face of the curb. A one-inch asphalt binder is then placed, mixed 5 parts A. C., 12 parts sand and 83 parts stone. This is spread and rolled in the usual manner and is followed with a top mixture which is rolled to a finished thickness of 1½ inches. The top mixture is proportioned 10½ parts A. C., 76 parts sand and 13 parts filler. These proportions are, of course, subject to more or less variations, according to the quality of the A. C. A. C. with penetration 50 at 77 degrees F. is used on most streets. A number of streets have been resurfaced by municipal forces during the past few years with very satisfactory results.

In East Cleveland, Ohio, a large number of streets had been laid with brick on sand without concrete base. Parts of this pavement in bad condition are removed and concrete laid to level this up with the original surface. The curb is removed, redressed and reset with drains under it. It is usually found necessary to remove about 1/3 of the area of the old pavement and replace about 1/3 of the curb. A 2-inch asphalt concrete top is then laid. The cost of this resurfacing is about 2/3 that of a new pavement with a 2-inch surface on a 6-inch base.

In Fremont, Ohio, badly broken areas of brick are removed, the sub-base is compacted and the space filled with concrete or binder to the general level of the original surface. At crossings and connections to other street pavement the brick is removed where necessary and replaced with concrete or binder, and the same is done wherever the pavement would be too high after resurfacing. The pavement is then thoroughly swept with steel brooms and flushed. Wherever depressions in the old brick exceed 3 inches in depth, the old pavement is taken up and replaced with portland cement concrete. Where the depth is less than 3 inches the hole is brought up to grade with asphaltic concrete binder. The old brick pavement is then treated with a paint coat composed of 2 parts of asphaltic cement dissolved in 3 parts of naphtha, which is applied to the brick after they are thoroughly dry and clean by means of sprinkling cans. Upon this is laid an asphaltic concrete binder 1½ inches thick and on this a 1½-inch asphaltic wearing surface.

(To be continued)

Hetch Hetchy Dam Concrete Plant*

Aggregate for 375,000 yards of concrete handled by steam shovel and railroad dump cars. Crushed, screened, washed and delivered by belt conveyors to 8,000-yard storage pile. Large mixers fed from overhead bins deliver maximum of 2,000 yards daily to quadruple 350-foot hoisting tower. Bulk cement unloaded by power scraper and binned with screw conveyor

The Hetch Hetchy dam will contain 375,000 yards of masonry, of which 300,000 yards of 1:3:6 cyclopean concrete will contain at least 10 per cent. of plums, at unit prices of $11.80 and $11.00 respectively for masonry laid below the original stream bed and above it. There will also be 75,000 yards of 1:2½:5 concrete at prices of $15.00 to $14.30 per yard respectively for that below and above the original stream bed. The concrete has now been laid up to an elevation above the original bed of the river and about one-half of the total amount has been placed by a specially designed digging, transporting, crushing, washing, screening, conveying, storing, mixing, hoisting and distributing plant that eliminates a large amount of hand labor and executes a large proportion of the work by gravity.

AGGREGATE

Sand is taken from a bank 30 feet high in a glacial deposit about 4 miles up stream from dam in the reservoir basin. A railroad track has been laid by the sand pit where a Marion No. 31 shovel with crawler tractor loads the sand into cars. The sand carries some oversize and requires screening, but no washing. A considerable amount of sand has to be wasted, however, as there is an excess of mica and organic matter.

Stone for concrete is excavated from a gravel bed about two miles above the dam, and the railroad to the sand pit also handles the stone. A Bucyrus 70 C standard shovel loads stone into the cars, which haul it to the crusher plant a quarter of a mile from the dam. All of the stone is washed.

CRUSHING PLANT

The crushing plant consists of a No. 10 Kennedy Van Saun primary crusher with 24x36-inch Power & Mining Machinery jaw crusher as an auxiliary. A 30-inch belt conveyor carries the product to a revolving screen, where it is washed and all passing a ½-inch mesh jacket is wasted through a sluice flume about 400 feet long.

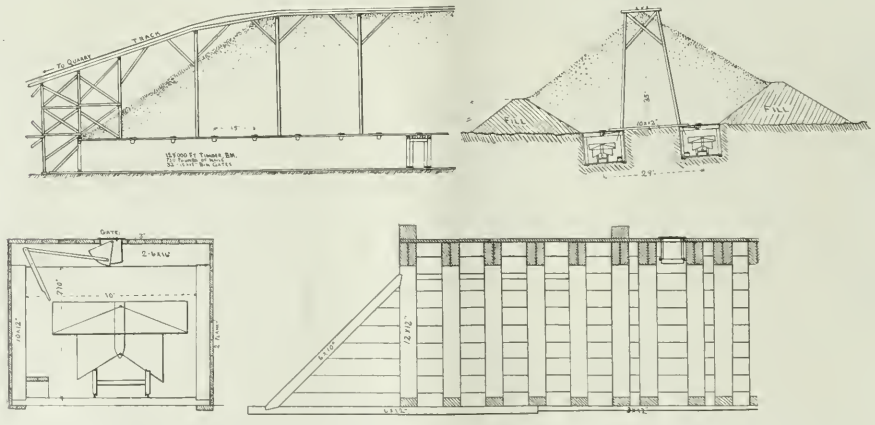
All material not passing the 2½-inch screen perforations is recrushed in a No. 6 McCully crusher and a No. 49 gearless Kennedy Van Saun crusher. After recrushing, the rock is again screened to take out the crusher dust and transported by a belt conveyor to 8,000-yard storage piles.

TRANSPORTING AND MIXING

Twin tunnels run under the storage piles and in them trains of 4-yard cars are loaded by gravity through gates in the tunnel roof and deliver the aggregate to the mixing plant.

Aggregates are brought to the dam from the storage pile in trains, each of twelve 4-yard cars, which dump the rock and sand into their respective bins over reciprocating feeders, which in turn deliver to 200-foot 30-inch and 24-inch conveyor belts traveling on a 33 per cent. slope to the mixer storage bins.

*The design of the Hetch Hetchy dam and the diversion work for its construction were described July 8th. The methods and plant for excavating the foundation, 117 feet below the bottom of the river, were described July 15th.



RECEIVING TRESTLE, STORAGE PILE AND DELIVERY TUNNEL FOR HANDLING CONCRETE STONE.

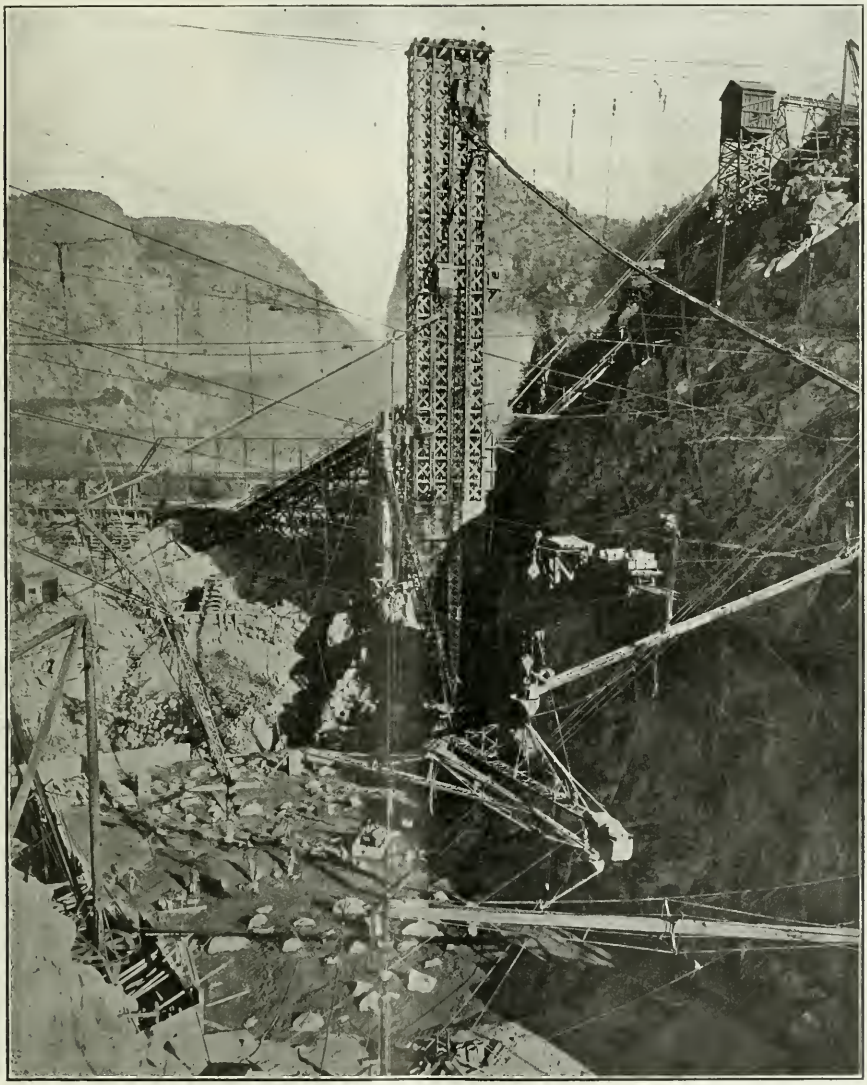
Cement is received in bulk, the cars being unloaded by an electrically driven power scraper which pulls the cement from the car to a hopper, which opens under the car door like a kitchen flour bin. This hopper feeds cement into 10-inch screw conveyors on 30 per cent. incline which take the cement to the top of a 13,000-barrel hopper-bottom storage house.

Under the storage bin there is a 4x6-foot tunnel in which there is installed another 10-inch screw conveyor which carries cement to the scale house. Batches are weighed on Hoepner automatic scales and dumped into an 8-inch pipe leading direct to the mixers.

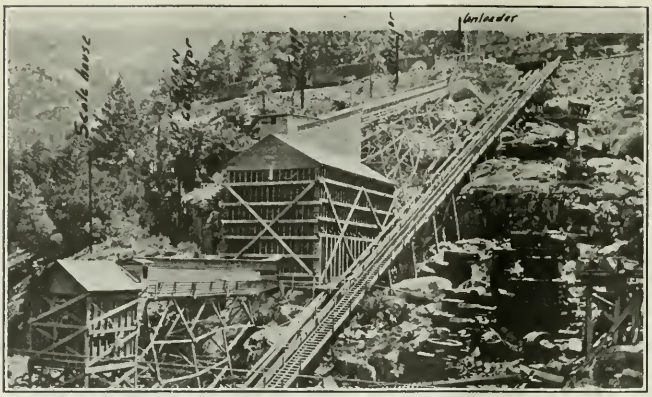
The mixing plant is located under 600-yard storage bins close to the face of the dam. Here two 81-foot Ransome mixers are operated by hydraulic cylinder control, which dump the automatic measuring boxes into mixers and dump the concrete out of the mixers, one man controling all the operations of each mixer.

DISTRIBUTING CONCRETE

The concrete goes from each mixer to a hopper, which discharges to 36-foot Insley tower buckets in



SPOUTING FOUNDATION CONCRETE THROUGH CHUTES SUSPENDED DIRECTLY AND ON TRUSSES FROM CABLEWAYS.



PLANT FOR UNLOADING, STORING AND DELIVERING AGGREGATE TO CONCRETE MIXERS.

a four-compartment wood tower 350 feet high, just beyond the up-stream face of the dam. From the tower the concrete flows in two lines of 16-inch chutes with double 50-foot counterweights. Two buckets dump into each line of chutes. The chute lines are suspended from 1¼-inch plow steel cables, and counter-weight sections from a 2¼-inch used cableway cable.

All materials and men are transferred from the Hetch Hetchy railroad tracks to the bottom of the foundation pit by a 15-ton Lidgerwood cableway which was also used to lower an 18-ton locomotive from the high level tracks.

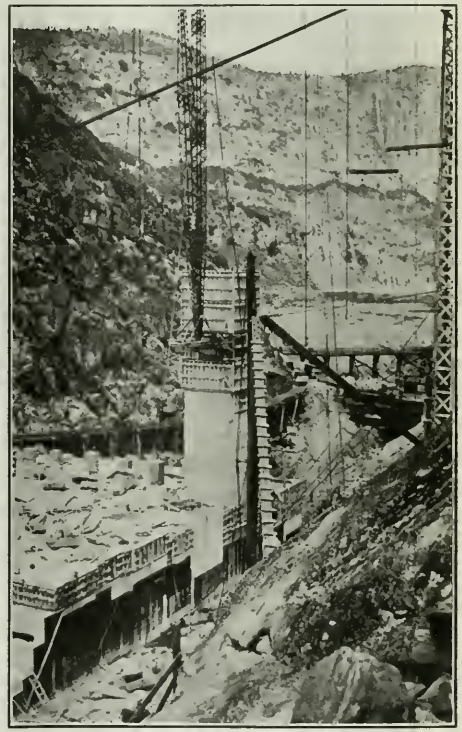
The derricks handling the cyclopean plums are installed high above the working level on 16x16-foot concrete solid pedestals that are eventually built into the body of the dam and form integral portions of it. They are carried up in courses built in telescopic sliding wooden forms handled by the derrick itself. During last March and April, when the work was partly shut down on account of an interruption in the power service, the pedestals were built up to a height of 60 feet above the general surface of the concrete by a small force of men working with the limited power available, and thus avoiding future delay for raising the derrick as the work progressed.

The concreting is largely done in two 8-hour shifts at the rate of about 40,000 yards per month. The crushing plant was designed by the Kennedy Van Saun Company and later modified by the contractor to give greater speed and capacity. The mixing and placing plants and bulk cement layout were designed by A. E. Paddock, construction engineer for the contractor. C. R. Rankin is the resident engineer for the city of San Francisco and H. J. Lawler is the contractor's representative.

Steel Distribution Mains in Detroit

The city of Detroit in 1921 laid as an experiment a quantity of small steel pipe. Of this, 4,577 feet was 13½-inch O. D. Matheson joint pipe as manufactured by the National Tube Co., 1,600 feet was 18-inch O. D. steel pipe laid with Dresser joints. The 13½-inch size was selected as this outside dimension is that of 12-inch Class C cast iron pipe, so that this steel pipe could be used interchangeably with 12-inch cast iron pipe in connection with fittings and valves. The thickness of wall of the 13½-inch steel pipe was .31 inch, and of the 18-inch was .33 inch. This pipe was made of the standard material used by the National Tube Co. and coated with their standard pipe dip. The pipe comes in approximately 20-foot lengths.

The Matheson joint is made with lead similar to the ordinary bell and spigot joint, but the lead space is a little smaller and the pipes are longer. The Dresser joint consists of a seeve, two rubber gaskets with followers and bolts. The Dresser joint pipe presents no difficulty in laying except that there are a number of bolts to be tightened up at each joint. Both joints were easily made tight and showed up well under test.



BUILDING 16 x 16 FOOT CONCRETE TOWER TO SUPPORT DERRICK AND AFTERWARDS FORM PART OF PERMANENT DAM.

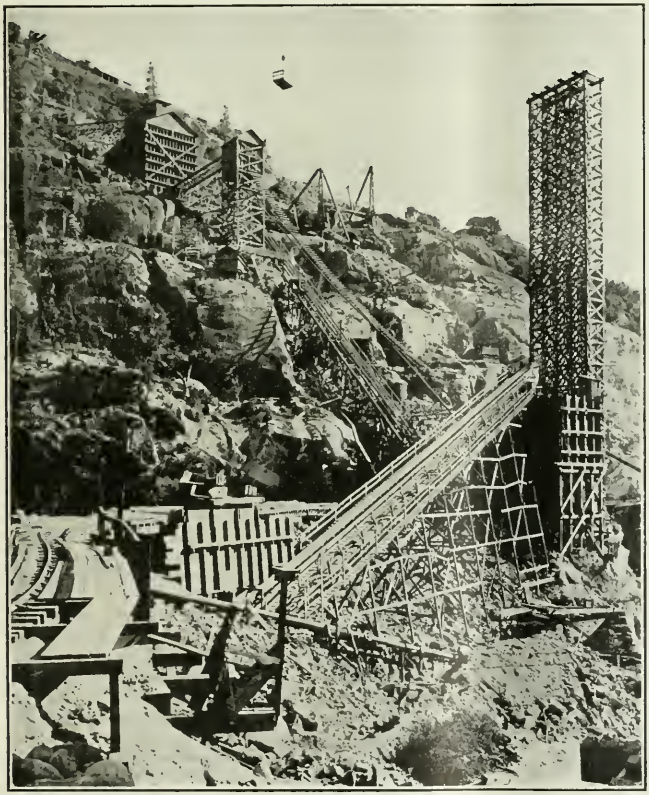
When necessary to cut the pipe, this is done with an acetylene torch. Considerable care has to be used in handling steel pipe of any kind so as not to damage the coating.

In tapping small steel mains on account of the thin wall there are only a few threads engaged between the corporation cock and the wall of the pipe. For this reason the 13½-inch O. D. has been limited to one-inch taps and no larger. On the larger sizes larger taps can be used, but considerable difficulty has been encountered with the taps themselves.

DERRICK TO HANDLE PLUMS INSTALLED ON CONCRETE TOWER.

Accuracy of Old Meters

There are in the city of Detroit about 150,000 meters in service. The water department tests large meters in place and systematically removes small meters for tests and repairs as one of the routine duties of the department. In less than five months of 1921 the department tested 3,544 meters of 2-inch size and smaller. Of this number only 1,545 were found to register within 4% of the correct amount. Nine registered between 4%and 10% too high, 29 between 15% and 25% too low, 125 between 10% and 15% too low and 1,028 between 4% and 10% too low. These meters had been in service from 8 to 31 years, and presumably had not been repaired or tested during that time.



CONCRETE PLANT AND QUADRUPLE HOISTING TOWER 350 FEET HIGH.

Hydrant Flow Survey

The 1921 report of the Detroit water board describes a hydrant flow survey covering the entire city which occupied five months of the fiscal year covered by the report.

"The object sought was to determine at all points the amount of water available for fire protection, and to do this the fire hydrants were divided into 1,500 groups of four each, and the amount of water discharged from three hydrants of each group was measured while the residual pressure was observed at a central hydrant. The discharges of the various groups were reduced to a 10-lb. basis; or, in other words, the discharge from each group was computed from the readings taken in the field to determine the amount of water available with a residual pressure of 10 lbs. These readings on the 10-lb. basis were posted on maps and the low areas were determined by inspection and used to determine the lines that should be laid for reinforcing the distribution system.

Engineers' Plans for State Health Boards*

Regulations of the State Boards of Virginia, Washington, West Virginia, Wisconsin, Wyoming, Philippine Islands and Arizona, with respect to the matter and form of plans and reports required to accompany applications for water and sewerage permits

Virginia—Requires one full set of general and detail plans, drawn to scale, white, blue or black line print. "Pencil sketches will not be accepted." Plans shall have the customary titles, points of compass, etc. General plan or layout, detail plans of structures, including purification plants, are called for in wording similar to the regulations of other states. Additional requirements are: "All emergency connections and valves by which water can be turned into the distribution system from any auxiliary or industrial supply shall be shown in detail and locations of each indicated on the general plan." "Detailed designs of filter equipment submitted by filter companies and made part of the plans shall be submitted for approval before construction of the plant begins."

The engineer's report shall contain the principal data upon which the designs were based, especially discussing surface supplies with and without purification and ground water supplies.

Detail specifications covering all the work must be submitted.

Washington—No special regulations as to plans or other information that must accompany application.

West Virginia—Water supply plans, specifications and report required in triplicate. They should include all necessary plans. No special scales or sizes of sheets are required, but should be such that all can be clearly understood and conveniently used; scales of 100 to 300 feet to one inch, and maximum size of 36x48 inches are suggested. The requirements for the engineer's report is a very brief summary of the points found in those of most of the states.

Wisconsin—*Water Works*—A general plan, scale from 100 to 300 feet to the inch, shall show the area of the district served. If the district is too large, it may be divided into sections accompanied by an index map. The general plan shall show all wells, intakes or other sources of supply; the purification plant, if provided; all mains, with their sizes and depths; all valves, hydrants, cross connections, etc., and storage or distribution reservoirs.

Detail plans shall be given of the crib, screens, etc., if water is taken from a stream or lake; if groundwater, details of the development of well, spring, or infiltration gallery, showing definitely the manner of protecting the supply from pollution where there is danger of such. A sketch is required showing all possible sources of pollution within 500 feet and the direction of the underground flow if known. Other plans shall show complete details of purification plant, including tanks, piping system, chemical mixers, rate controllers, etc. Others shall be given of pumping station and equipment, any special features of the distribution system, elevated tanks, reservoirs, etc. Complete specification covering the construction shall be submitted.

The engineer's report must discuss the following subjects: The municipality, community or institution, its population, etc.; the source of supply, including analyses if possible; purification; distribution system; pumping equipment; storage; fire protection. An estimated cost shall be given of developing the source of supply, of the pumping equipment, each unit of the purification plant, the distribution system and any reservoirs; for both the complete system designed and for that which is to be constructed at once.

In connection with these requirements as to plans, the board has prepared a number of requirements as to design, under the general heads of provision for future requirements, protection of source of supply, pumping equipment, purification, by-passes and cross connections, distribution systems, and fire protection.

Sewerage—Regulations as to scale and size of general plans are the same as for water. The general plan shall show the topography; location of any sources of public water supply; location, sizes, grade and direction of flow of each sewer, elevation of invert and depth of cut or street elevation at all manholes; also location of outlets, treatment plants, manholes and all appurtenances, pumping stations, etc.

Detail plans shall show cross sections of all sewers unless made of standard pipes; manholes and other appurtenances; pumping equipment, if required; and map of property to be used for disposal plant with topography and location of the several units, the details of each unit, including elevations of the various parts of the plant and of high and low water levels in the water which will receive the effluent. Complete specifications must accompany the plans.

The engineer's report must discuss the population, water supply of the community, provision for present and future needs as to sewerage, extent of construction now contemplated, character of industrial wastes, the sewer system, type of purification, character of soil, high and normal groundwater level, and estimated cost of each part of the complete system.

These regulations also are accompanied by requirements as to design, such as that provision must be made for at least 25 years in advance, especially as to main sewers. Pumping equipment and sewage treatment plants need be only of sufficient capacity to amply meet present requirements, but with provision for extensions. All new systems must be designed on the separate plan, and in case of existing combined sewers provision shall be made for storm water overflows and in extensions no more storm water shall be admitted to these sewers, and efforts shall be made to convert the system from a combined to a separate system. The sewers are to be laid to the grades which were required in the regulations of Arkansas and many of the other states.

Some of the general requirements as to sewage

*The last of a series of articles begun in the issue of April 8.

treatment plants are as follows: Rates of operation must not exceed a detention period of 8 hours in septic tanks; should be between 2 and 3 hours in Imhoff or similar tanks, which should have a sludge capacity of one cubic foot per capita below a horizontal plane 18 inches below the slot. Intermittent sand filters, not more than 1,000 persons per acre, with a minimum depth of 3 feet. Contact beds, not more than 1,000 persons per acre per foot of depth with a minimum depth of 4 feet. Trickling filters, not more than 3,000 persons per acre per foot of depth with a minimum depth of 5 feet. In sand filters, an effective size not less than .2 mm. nor more than .4 mm. Stone in contact beds, not less than ½-inch nor more than 2 inches; and in trickling filters between ¾-inch and 2½ inches. A competent person shall be put in charge of the operation of every water purification or sewage treatment plant and personally supervise its operation.

Wyoming—So far as we know, no special regulations as to size or nature of plans have been published by the state board.

Philippine Islands—There are neither laws nor requirements governing the preparation of plans for sewerage systems or water supplies in the Philippine Islands. The director of health of the Philippine Health Service, under date of May 24th, stated that the practice being followed was as follows: "Projects concerning these matters originate from district health officers who, with the co-operation of the district sanitary engineers, prepare a report to the director of health. If approved, the report is forwarded to the director of public works for the preparation of plans, details and specifications. When all the plans are finally approved and appropriation for the expenses available, the construction is carried out under the supervision of the chief sanitary engineer of this service."

Since publishing a synopsis of the laws requiring submission of plans to state health boards in the issues of April 8th and April 22nd, we have received the following additional information:

Arizona—There is no department of sanitary engineering in this state nor any regulations for sewerage and water supply systems. The Arizona state laboratory co-operates with the various municipalities in an effort to obtain water that will meet the requirements for common carriers established by the U. S. Public Health Service, but can act in only an advisory capacity.

Fire Hazard of Pumps

The National Board of Fire Underwriters considers electric pumps of low reliability because of the danger that the transmission of current to the plant may be interrupted by one of several causes. An illustration of this liability was given in Waltham, Mass., in December, 1921. This happened to be at a sewage pumping station rather than at a water works pumping station, but the illustration is equally pertinent.

The city has one isolated centrifugal pumping plant operated automatically by electricity. This plant during the year pumped about 14,500,000 gallons against a head of 29 feet, using for this purpose 6690 kwh. of which the cost was 7.66 cents per kwh. A severe ice storm resulted in a shutting off of the supply of current and the plant was without electric power for 30 days, during which time it was necessary to keep gasoline pumps constantly in action in order to keep sewage from flooding the low-level section of sewers.

Trees for City Streets

The U. S. Dept. of Agriculture has published a pamphlet of 40 pages containing a great deal of information concerning trees for town and city streets which is presumably reliable and should be in the hands of every official who has charge of or is interested in the shade trees of his community.

Oak trees are considered to be the best trees for street planting. It is thought that the prevalent belief that they are slow growers and the fact that in the north they are rather difficult to transplant are chiefly responsible for the limited use of them. However, a white oak, which is one of the slow growing varieties of oaks, will reach the same height as a sugar maple in the same period of time and maples are one of the most widely used shade trees in the north. The department gives elms second place in desirability for city trees and sycamores third. Most varieties of poplar are not recommended except the lombardy poplar.

Trees native to one part of the United States may not thrive in another part, while some are objectionable in any part either because their roots penetrate open sewer joints, grow so near the surface that they tend to heave and crack sidewalks, or because of other objectionable characteristics.

Trees that thrive in cities must withstand dust and smoke in the atmosphere, unusual and frequently unfavorable soil conditions, restricted feeding areas, interference with the roots occasioned by underground structures, etc. The shape of the top of a full-grown tree should be suited to the width of the street. The foliage should not be too dense and should be of a pleasing texture and color. The resistance of the tree to vegetable and insect pests and diseases is an important consideration. Evergreen trees should be planted only in the most southern parts of the country where there is abundant sunlight in the winter. Desiduous trees that will admit all the light possible should be used in the north.

Narrow streets should be planted with tall slender trees like the lombardy poplar while broad streets may be planted with spreading trees.

For use within reach of ocean spray or on sandy land near the coast, the red oak and the red or scarlet maple are suitable as far south as Charleston, S. C., while the sweet gum and live oak are equally good from Norfolk southward and along the gulf of Mexico. The red oak, sweet gum, red maple and eastern live oak are all grown successfully along the Pacific Ocean, while the California live oak can be used from San Francisco southward.

The trees that best endure the most alkali appear to be the bladdernut tree, the London plane, peppermint gum and hardy fan palms. In the heart of a city the ailanthus will probably thrive when nearly all other trees fail, although the sycamore and London plane are also good for such localities, as are also the Carolina poplars.

The pamphlet can be obtained upon application to the Department of Agriculture at Washington.

A New Method of Rating Water-Bearing Sands and Gravels

By W. G. Kirchoffer*

Methods employed for filter sands are not well adapted to the coarser sand and gravel strata. New method suggested by Prof. Abrams' "Fineness Modulus" for concrete sands.

A knowledge of the size of sand grains and the amount held on each size of a nest of sieves aids greatly in a study of any sand for either artificial filtration of water or sewage, or for a study of the flow of underground waters through a given sand bed.

Many years ago there was devised in the Lawrence experiment station a method for the study of filter sands. This analysis involves the determination of the "Effective Size" and "Uniformity Coefficient." These are found by separating the sand into sizes by a nest of sieves and the platting up of percentages by weight held on each sieve. A curve is drawn through these points and where it cuts the 10% line this is the "Effective Size." This size is such that 10% of the material is of smaller grain and 90% is of larger grains than the given size. The results of the work at Lawrence Experiment Station indicated that the finer 10% have as much influence upon the action of the material in filtration as the coarser 90%. This is explained by the fact that in a mixed material the water is forced to pass through the small interstices made by the finer material. It is this finest portion which mainly determines the loss of head in the sand.

"Uniformity Coefficient" is a term used to designate the ratio of coarse to fine particles, and is the ratio of the size of the material with 60% finer to that size which has 10% finer. These sizes have to be picked from the curve above referred to.

Hazen in describing the above coefficient remarked that further study will likely modify or change the method of calculation. This method of rating sands involves five distinct processes: Sifting, computing percentages, plotting curve, picking off values at 10% and 60% and computing uniformity coefficient.

These factors or coefficients of physical qualities of sands as applied to filter sands are not so well adapted to serve as an index for rating water bearing sands and gravels as they have been found to be for filtration. One of the principal reasons is that the samples from such formations are usually obtained by the use of a churn or hydraulic drilling machine, and no matter how coarse the materials may be, the drill will always make some more fine particles. In any sample of drilling it is easy to find 10% that would pass an 80 or 100 mesh sieve. This would then determine the effective size, although there might be a large percentage of gravel in the sample tested. This fine material, artificially made, would have a double effect on the uniformity coefficient as it would not only influence the effective size, but would also increase the percentage of the volume under 60%.

Another reason is that filter sands are actually screened between relatively close limits as to size, whereas sands and gravels found in the natural state may vary between almost any limits as to size. Two samples of natural sand and gravel might have about the same amount of fine material of the same size, making up the 10% of fine material, but might be totally different in the 90% which would not be revealed by this analysis.

Material used for filters usually remains in place, that is, a very small percent of the fine particles are washed away with the effluent. This, however, is not the case with water bearing sands and gravels when used as a water supply. Many screens are put in wells with the express purpose of removing the fine material by pumping and flushing. Few successful wells have screens less than 60 meshes per inch, except those used in individual supplies. With water supplies, much of the fine material which would make up the percentage of the material used in filtration, would be washed away and not be considered where it was vital. The rating of water bearing sands on the basis of the fine material does not reveal its real characteristics.

I think that those who have had experience in developing water supplies from water bearing sands and gravels will agree with me that material which will pass a 60 mesh sieve is of comparatively little value for this purpose.

When Prof. Abrams of Stevens Institute brought out his "Fineness Modulus" for rating sands and gravels for concrete work, it gave me a suggestion that a similar factor might be worked out on water bearing sands and gravels. During the last 15 years I have analyzed a number of sands and gravels for water supply purposes, and for a number of years used the "Effective Size" and "Uniformity Coefficient" as an index to the relative value of the material for water supply purposes. The records of the sieve analyses have been preserved and are now available for comparative purposes by the new method that is about to be explained.

My set of sieves did not correspond exactly with Abrams, but for my purpose this was not necessary. My sieves are 4, 10, 20, 30, 40 and 60 meshes per inch. To determine the fineness modulus with this set of sieves it is only necessary to add together the total percentages by weight that are held on each sieve. The sixty mesh sieve would, of course, hold its own portion and all that which is held on the larger sieves up to and including No. 4. Likewise the 40 sieve would hold its own and all that on the large sieves. The determination of the fineness modulus for a sand from Stevens Point, Wisconsin, is given in Table No. 1.

From this table it is seen that for this particular set of sieves the fineness modulus is made up of 6 times the percentage held on sieve No. 4, five times that held on sieve No. 10, four times that on No. 20 and so on down to once on No. 60.

Another way of stating it would be that the gravel

* Sanitary and hydraulic engineer.

Table No. 1	Percent by weight held on each Sieve						Total percentage Passed No. 60	held on each
	No. 4	No. 10	No. 20	No. 30	No. 40	No. 60		
60	4.4	9.94	6.16	12.00	30.20	29.90	7.60	92.60
40	4.4	9.94	6.16	12.00	30.20	....	....	62.70
30	4.4	9.94	6.16	12.00	....	....	....	32.50
20	4.4	9.94	6.16	....	....	....	....	20.50
10	4.4	9.94	....	....	....	....	....	14.34
4	4.4	....	....	....	....	....	....	4.40
Fineness Modulus								227.04

held on No. 4 sieve is given relative weight of six, that on No. 10 a weight of five and so on to a weight of one for No. 60. All material passing No. 60 is discarded. If a larger portion passes No. 60 the part remaining on the sieves is likewise less and thus the fineness modulus is indirectly effected by it.

With this method it would be impossible to get a fineness modulus greater than 600 even if all of the material was held on a No. 4 sieve, but it might be as low as zero if all of the material passed a 60-mesh sieve. If it was all held on a 60-mesh, but passed the 40-mesh, the fineness modulus would be only 100. If it was all held on a No. 40 mesh the fineness modulus would be 200. If held on No. 30, 300; No. 20, 400; No. 10, 500, etc.

Any composite sand having a fineness modulus of 200 or thereabout, might for comparative purposes, be considered as one held on a No. 40 mesh sieve.

While these indices may not be theoretically correct for the permeability of sands assorted in this way, yet it is rating them in a relatively correct manner. That is to say, the coarser the sand and the more gravel there is, the greater will be the flow through a material under the same conditions.

After having settled on this method for an index, I went back to some of my records of sands and gravels where I had developed a satisfactory supply and previously used the "Effective Size" method and determined the fineness modulus for that supply as follows:

Antigo	267
Tomahawk	213
Medford	303
Marshfield	198
Shawano	253
Wisconsin Rapids	139
Stevens Point	271
Nekoosa-Edwards P. C.	298
Delavan	362
Marathon Paper Co.	388

From actual experience with these supplies I have been able to draw the following conclusions in a general way. Where the fineness modulus is 100 or less the sand and gravel is of little value as a water supply or we could rate it as *very poor.;* 100 to 140 poor, 140 to 200 fair, 200 to 250 good, 250 to 300 very good and over 300 excellent. This sort of an analysis determines conclusively a total figure for fineness modulus, but it does not show at a glance just how this fineness modulus was made up; that is, two good sands might vary greatly in the percentage held on No. 4, No. 10, and No. 20 and still have about the same high fineness modulus.

I have, therefore, prepared a chart showing the weighted percentages held on each size, beginning with No. 4 and accumulating the weighted percentages until the 60 size is reached. Curves for several sands analyzed in this way are shown in Fig. 1. It will be noted that nearly all of the curves have the same general form. This chart shows also some analyses made on proposed supplies that have not been developed and some poor material encountered at Stevens Point and Waupaca.

All of the samples taken from formations that are continuously sand and gravel from top to bottom have the reverse or ogee type of curve. Those from formations that alternate with layers of clay and sand have curves convex upwards as Marshfield, Medford and Delavan. It will also be noted that the

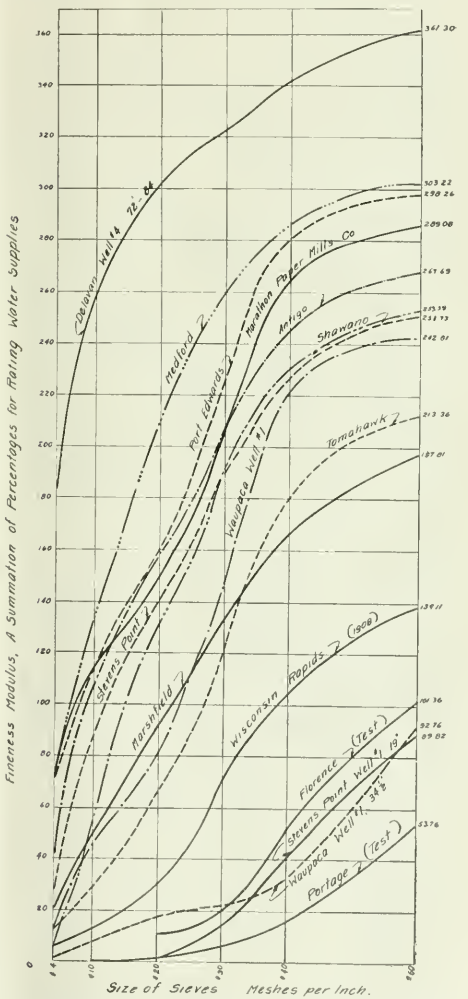


CHART SHOWING FINENESS MODULUS BY SIEVE ANALYSIS OF WATER-BEARING SANDS AND GRAVELS.

ones of the highest modulus have flat curves in their upper portion. This tells to the eye at once that the amount of fine material present is very small, whereas those of low moduli as Wisconsin Rapids, Portage, etc., have steep curves in their upper portions.

The material from Delavan is remarkably peculiar. It is a material made up almost entirely of Trenton limestone chips. It has been worked over by the ice and water very little as there are few rounded grains. This perhaps accounts for the high modulus.

The Wisconsin Rapids' supply was developed before this method of rating was devised. It has not proven very satisfactory, therefore, any sand and gravel having a fineness modulus below this is rated as very poor and is not used where other sources are available.

The Portage sample was borrowed from Mr. Tannant, City Engineer, who was having test wells put down. I understand a well concern in the South proposes to develop a supply in this material. From my way of thinking they will be disappointed.

For convenience in the study of any proposed supply I have prepared a chart shown in Fig. 2. This has been prepared by taking averages of the different grades of sands shown in Fig. 1 and noting the separation in grades given above as very poor, poor, fair, etc. One or more of these charts can be used for each study and when a final conclusion is reached the resulting curve can be plotted on Fig. 1 for exact comparison with the supplies previously developed.

This method is simple, can be easily applied by any office assistant after a little practice. It is much easier to work out than the size of the sand grains in millimeters and when once done means much more to the investigator.

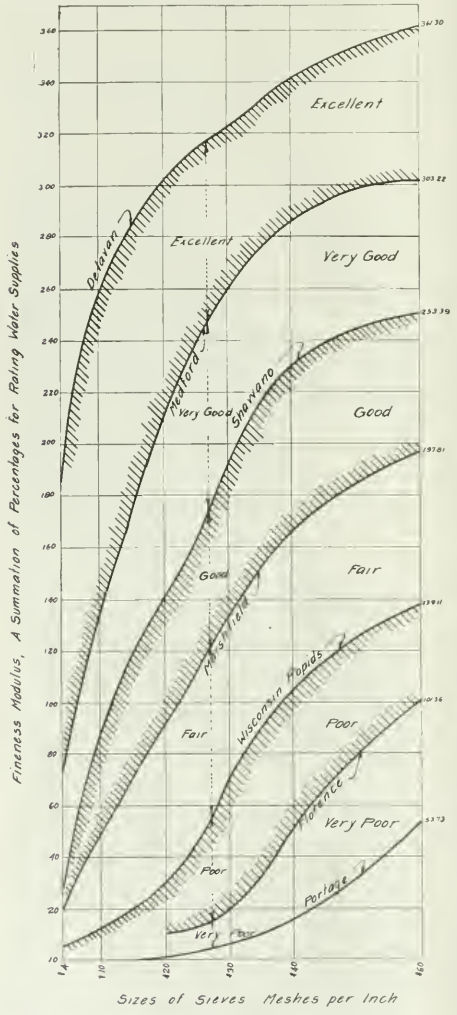


CHART FOR CLASSIFYING WATER-BEARING SANDS AND GRAVELS BY SIEVE ANALYSIS.

Contract for Buffalo's Filter Plant

Bids were received on July 11th for the concrete substructure for the filter plant at Buffalo, N. Y., four bids having been received, from the John Johnson Construction Co. and the Buffalo Dredging Co., both of Buffalo, from A. Bentley & Sons Co., of Toledo, and from the Thompson-Starrett Co. of New York.

The work included excavation of earth and rock, construction of a cofferdam and, in the structure itself, reinforced concrete with copper expansion joints and several tons of cast iron pipe and iron and steel work. The largest quantities in the estimate were 360,000 cubic yards of general earth excavation, 20,000 cubic yards of earth excavation for conduits, 7,000 cubic yards of rock excavation, 110,000 cubic yards of earth embankment, 55,000 cubic yards of concrete masonry and 3,500 tons of steel reinforcement.

Two separate estimates of cost had been made, one by the water commissioner, George C. Andrews and the other by the consulting engineer, Harrison P. Eddy; the former having estimated the total cost at $2,085,150 and the latter at $2,097,200. Mr. Andrews' estimates were based on common labor at 40 cents an hour, cement at $2.26 net per barrel, gravel and sand at $1.60 net per yard delivered by trucks, lumber at $45 per thousand, coal at $5 per ton, electric power at 1½ cents per kwh., and reinforcement steel at $40 per ton; with an estimate of $200,000 as the capital requirement for conducting the work.

Estimates and bids for some of the largest quantities were as follows: General earth excavation, estimates $1.25 and $1.40; bids 60 cents, 93 cents, 94 cents and $1.50. Earth embankment, estimates 25 cents and 75 cents; bids 25 cents, 48 cents, 50 cents and 56 cents. Concrete masonry, estimates $20 and $17.50; bids $16.00, $16.00, $18.75 and $20.00. Steel reinforcement, estimates $85 per ton and $100; bids $68.45, $70, $74.50 and $90.

The totals of the four bids were as follows: $1,800,480, $1,801,765, $2,014,275, and $2,126,400.

PUBLIC WORKS.

Published Weekly
at 243 W. 39th St., New York, N. Y.

S. W. HUME, President J. T. MORRIS, Treasurer

Subscription Rates
United States and Possessions, Mexico and Cuba $3.00 year
All other countries..... 4.00 year
Change of Address
Subscribers are requested to notify us promptly of change of address, giving both old and new addresses.

Telephone (New York): Bryant 9591
Western Office: Monadnock Block, Chicago
A. PRESCOTT FOLWELL, Editor
FRANK W. SKINNER, Associate Editor

CONTENTS

RESURFACING OLD PAVEMENTS..... 55
HETCH HETCHY DAM CONCRETE PLANT. Illustrated 58
Steel Distribution Mains in Detroit..... 60
Accuracy of Old Meters..... 61
Hydrant Flow Survey..... 61
ENGINEERS' PLANS FOR STATE HEALTH BOARDS 62
Fire Hazard of Pumps..... 63
Trees for City Streets..... 63
A NEW METHOD OF RATING WATER-BEARING SANDS AND GRAVELS. Illustrated. By W. G. Kirchoffer..... 64
Contract for Buffalo's Filter Plant..... 66
EDITORIAL NOTES 67
Plans for Sewer and Water Works Systems—Construction Economics.
Cambridge Water Works Notes..... 68
Wear of Concrete..... 68
Extensive Highway Work in Florida..... 68
WATER WORKS SERVICES. Tables..... 69
Automobiles Break Hydrants..... 73
RECENT LEGAL DECISIONS..... 74

Plans for Sewerage and Water Works Systems

We conclude this week the series of articles that we have been publishing under the heading "Engineers' Plans for State Health Boards," in which we have given synopses of the legal requirements of the several states as to submission of plans for sewerage or water works systems to their state health boards and the rules of the boards specifying size, scale, etc., and contents of such plans and reports.

In a few states the boards of health have been organized only a few months and have not yet prepared regulations of this kind, although expecting to do so. In other states no power is given to the boards of health to require that plans be submitted to them, but several have induced the engineers generally to voluntarily submit such plans to them.

In the majority of states, however, the state boards have the power to require plans of this kind and the most of them have prepared rules and regulations specifying what information must be given and in what form. Of these last, a considerable number have adopted regulations that vary from each other in only minor details, among these being Arkansas, California, Georgia, Iowa, Louisiana, Montana, New Jersey, North Dakota, Oklahoma and Texas; while a few others do not differ from these in the essentials of their regulations.

On the other hand, two or three of the state boards express the opinion that it is undesirable to specify too exactly as to the plans to be sumbitted, especially the size and scale, since these might conflict with the standards adopted in the offices of the various engineers. Whether or not the rather minute details found in some of the regulations are desirable as essential requirements, they are at least of value to the younger engineers in indicating to them what plans, reports, etc., are considered essential for a complete design and what scales and dimensions are considered to be most suitable for maps and other drawings.

Construction Economics

Engineering skill of a high order is necessary for the design and construction of a great water supply plant especially when it comprises unusually large and costly features like those of the Hetch Hetchy system described in this and previous issues. The best technical results are not, however, limited to safety, durability and efficiency of the permanent structure. To obtain the highest success the engineer must also provide for rapidity, safety, minimum cost and simplicity of construction and plan to utilize to the utmost the potential elements of the temporary operations, thus exemplifying the fundamental definition of the civil engineer—"One who best utilizes natural forces and materials for human welfare, construction and operations."

Ability of a high order has been displayed by the engineers and builders of the new San Francisco water supply system, in the construction of which several important features stand out prominently in making the work easier, cheaper and quicker. Several million dollars were wisely spent at the outset in auxiliary construction of a temporary nature, including the building of a long line of railroad, highway construction, and the installation of a complete and powerful hydro-electric plant to furnish a very large proportion of all the power needed for mechanical operations in the heaviest, most difficult and remote parts of the construction. The dry season water supply for the hydro-electric plant is impounded by a concrete arch dam that will eventually be enlarged for the construction of a permanent reservoir for a portion of the regular city water supply.

The construction of the Hetch Hetchy dam, which will be one of the largest in the world, has been planned in two successive operations, the second of which will involve a large fraction of the total minimum cost and may be several years delayed so as to eliminate a very important interest charge, and avoid heavy expenditures under the inflated prices prevailing when the work was commenced. The first portion of the dam is so designed as to be a complete and independent structure affording abundant service for a number of years and designed to be enlarged without extra expense or any change of plans under the given requirements.

In addition to these primary economics, important advances have been secured by the contractor by installing a number of construction plants in harmony with geographical conditions and in such a manner as to minimize hand labor, provide a normal storage

of materials sufficient to safeguard against any probable delays or interruptions, and to secure rapid, efficient and continuous deliveries of them from storage to the dam site and their distribution to the different parts of the structure by standard methods of recognized efficiency. Part of the work could have been executed without some of the heavy initial expenditures, but the total cost and delay would have been increased and the contractor's profits would have been greatly reduced by such omissions.

Cambridge Water Works Notes

The following items of interest appeared in the 1921 report of the water board of Cambridge, Mass., of which Walter H. Harding is registrar and Timothy W. Good is superintendent.

In preparing for the operation of the proposed filtration plant, plans for which had been prepared by George A. Johnson, the water board has for several years past been cleaning the mains of the distribution system so that the filtered water will not be again contaminated by deposits in the pipes. Over 7 miles of mains had been cleaned in the year covered by the report and 23.7 miles in the previous five years, this including all the large feeders of the system.

The city at the time of the report had 59 "Detector" and "Protectus" meters on fire supply lines, 4 of these being 8-inch, 8 of them 4-inch, 5 3-inch and the remainder 6-inch. In addition to these there were 14 large meters on fire supply lines. In addition to these 73 metered fire supply lines, there were 178 large supply lines unmetered. The majority of these were 6-inch, but there were 8 8-inch, 44 4-inch, 1 3-inch, 11 2-inch and 3 1½-inch fire services. In a number of cases two or more large services were laid into a single plant, one company having an 8-inch and a 6-inch service in each of two plants, another a 4-inch and 6-inch in one plant.

In addition to the meters on fire supplies there were 6,762 meters on other supplies, most of these being ⅝-inch and ¾-inch, although about 100 were of sizes up to 6 inches. Seventy meters were on school houses and other public buildings.

Under the head of pumping stations, Superintendent Good reported: "The installation of the Payne Dean electric controls has been a great factor in the working of our three large gates which we had equipped this year. The value of these electric devices is so great that I hope that the board will consider placing them on our other large gates as soon as possible."

Wear of Concrete

There has recently been published a report by Duff A. Abrams, professor in charge of the Structural Materials Research Laboratory of Lewis Institute, giving the details of tests carried out by the laboratory to determine how the wearing qualities of concrete are affected by the character of the ingredients, quantity of mixing water, time of mixing, age of concrete and other conditions. About 10,000 blocks were tested for wear and several thousand compression cylinders and miscellaneous specimens. The amount of wear was measured by the thickness of concrete removed by the test. In making the test the Talbot-Jones rattler was used. In this was placed a ring of 10 separately molded concrete blocks 8 inches square and 5 inches thick, fastened as a lining around the circumference of the rattler. The surfaces of the blocks were subjected to the tumbling action of a 200-pound charge of cast iron balls for 1800 revolutions, which were made in about one hour. In most of the tests blocks were used which had been stored for 14 days in damp sand or moist air and 76 days in air at ordinary humidity.

After describing the tests in considerable detail, the report gives the following conclusions:

(1) The wear on separately molded concrete blocks tested in the Talbot-Jones rattler was much more severe than any encountered in service; however, the test is believed to give trustworthy information on the wearing resistance of concrete of various proportions, consistencies, curing conditions, ages, etc., for use in concrete roads and pavements.

(2) A standarized practice must be followed in making the specimens and conducting the tests if consistent and reliable data are to be secured.

(3) In general the factors which gave concrete of high strength also gave concrete of low wear (a high *resistance to wear*).

(4) Increasing the quantity of cement reduced the wear.

(5) Increasing the quantity of mixing water, beyond the minimum required to produce a plastic concrete, caused a material increase in the wear.

(6) The coarser the grading of the aggregates, up to certain limits, the lower the wear.

(7) Curing concrete under favorable conditions exerted a marked influence in reducing wear.

(8) Wear was materially reduced by longer mixing of the concrete.

(9) Wear was reduced (resistance to wear increased) with the age of the concrete.

(10) The quality of the fine or coarse aggregate produced less effect on wear than is commonly supposed. The wearing resistance of concrete is determined largely by the *quality of concrete* rather than by the type of aggregate. Good concrete can be produced from aggregates which are generally considered inferior, if other factors are properly taken into account.

(11) The wear of concrete was not sensibly increased by the presence of hydrated lime or other powdered admixtures up to 20 per cent. of the volume of cement.

Extensive Highway Work in Florida

Florida stands well up with the largest states of the country this year in the amount of highway work that it is doing or contracting for. A recent illustration of this is a letting on July 5th by Pinellas county, when contracts aggregating nearly $2,250,000 were let for work in that one county. This included about 600,000 square yards of vitrified brick on a base of compacted rock 5 inches thick and with a 6 by 15-inch concrete curb; also about 400,000 yards of 2½-inch sheet asphalt on a 6-inch base of compacted rock, together with $108,000 worth of reinforced concrete bridges. The contract price for the vitrified brick was $1,301,854 and that for the sheet asphalt was $804,785.

Water Works Service

Continuation from the July 15th issue, of tables prepared from data furnished by superintendents of nearly eight hundred cities.

Municipality.	Private (P.) or municipal (M) plant.	Services laid preparatory to paving, before needed for use. Are they required by city?	Kind of pipe specified.	Depth specified.	Trouble experienced with them after laying.
Mississippi:					
Charleston	M.	yes	½" up	2 ft.	none
Tupelo	M.	no	....	3 ft.	none
Missouri:					
Chillicothe	M.	no	no spec.	no spec.	occasionally freeze
Fulton	M.	no	...	...	.....
Montana:					
Bozeman	M.	yes	l.	5 ft.	none
Havre	M.	no pav.	l.	6 ft.	none
Kalispell	...	to prop. line	l.	4' 6"	none
Lewistown	M.	no	l.	5 ft.	.....
New Hampshire:					
Newport	M.	no	...	...	.....
New Jersey					
West Orange	P.	yes	gwi.	4 ft.	none
New Mexico:					
Deming	M.	no pav.	...	...	.....
Tucumcari	M.	no	gs.	2 ft.	none
New York:					
Little Falls	M.	yes	l.	5 ft.	none
Medina	M.	yes	l.	3½ ft.	none
Oneida	M.	yes	l.	5 ft.	none
Owego	P.	yes	...	4½-5 ft.	none
Potsdam	M.	yes	gs. or i.	5 ft.	gooseneck burst
Tonawanda	M.	yes	l. ⅝"	4 ft.	none
Whitehall	M.	no	l.	4 ft.	careless plumbing, supporting & shallow laying
North Carolina:					
Concord	M.	yes	no spec.	2 ft.	none
Elizabeth City	P.	optional with co.	¾" i.	18 in.	.....
Henderson	P.	yes	¾" gs.	24 in.	clogging if unused
Kinston	M.	yes	g.	24 in.	gooseneck breaks sometimes near corp. cock
Washington	...	yes	¾" g	18 in.	none
North Dakota:					
Bismarck	P.	no	l.	7' 6"	none
Mandan	M.	yes	l.	7 ft.	none
Minot	M.	yes	¾", 1" l.	8 ft.	.....
Ohio:					
Bellevue	M.	no	...	3-4 ft.	sometimes freezing
Bowling Green	P.	yes	l.	4 ft.	.....
Celina	M.	yes	l.	3½ ft.	none
Conneaut	M.	yes	g.	4½ ft.	none
Delaware	P.	yes	no spec.	3½ ft.	none
Dennison	P.	yes	½" l.	4 ft.	none
Greenville	M.	yes	l.	4 ft.	electrolysis only
Leetonia	M.	yes	l. at main gwi. to curb	...	none
Logan	M.	yes	¾"—1"	3 ft.	none
Marietta	M.	yes	g. or l.	3 ft.	practically none
Middleport	P.	no	...	5 ft.	.....
Oberlin	M	yes	l.	5 ft.	none
Ravenna	M	yes	¾" g.	4 ft.	service to curb have given considerable trouble, average life 8 yrs.

Municipality.	Private (P.) or municipal (M) plant.	Services laid preparatory to paving, before needed for use. Are they required by city?	Kind of pipe specified.	Depth specified.	Trouble experienced with them after laying.
South Carolina:					
Chester	M.	...	gl., l. connections	no spec.	none
Sumter	M.	yes	g. pipe, l. to main	2 ft.	very little
South Dakota:					
Rapid City	M.	yes	l.	5 ft.	none
Watertown	M.	yes	l.	7 ft.	none
Yankton	M.	yes	l.	5 ft.	none
Tennessee:					
Clarksville	M.	yes	l.	2½ ft.	none
Covington	...	yes	l.	...	none
Dyersburg	M.	yes	l.	24 in.	none
Fayetteville	M.	yes	g., l. gooseneck	18 in.	small leaks in gooseneck
Jackson	M.	no	l.	2½ ft.	very little
Johnson City	M.	yes	g.	18 in. or 2 ft.	.....
Texas:					
Bryan	Me	usually not	l.	12-18 in.	.....
Childress	M.	yes	...	16 in.	none
Clarksville	M.	yes	l.	12 in.	none
Corpus Christi	...	no	l.	30 in.	iron rust out in 15-20 years
Del Rio	M.	no	...	...	.....
Eastland	M.	yes	l.	18 in.	none
Galveston	M.	no	separate 2" tap at each corner of st.	18 in.	giving out—old
Georgetown	M.	yes	black pipe, l. gooseneck	2 ft.	none
Gonzales	P.	no	½" taps for residence	no spec.	.....
Gorman	M.	no	none	30 in.	none
Greenville	M.	yes	l.	...	none
Longview	M.	yes	l.	3 ft.	.....
McKinney	M.	yes	l.	18 in.	scale over ½", services not in use
Navasota	P.	no	...	18 in.	.....
Orange	P.	yes	l.	18 in.	.....
Weatherford	P.	no	...	18 in.	little trouble
Utah:					
Brigham	M.	yes	g.	4 ft.	none
Vermont:					
Bennington	M.	yes	l.	5 ft.	frost
Brattleboro	P.	no	...	5 ft.	.....
Washington:					
Aberdeen	M.	no	...	...	settlement of pavt. breaking services
Anacortes	M.	yes	g.	20 in.	none
Auburn	M.	no	...	...	.....
Bellingham	M.	no	no. spec.	24-42 in.	.....
Cle Elum	M.	no pav.	...	...	.....
Dayton	M.	yes	g.	24 in.	none
Ellensburg	M.	...	...	...	.....
Hoquiam	P.	no	...	2 ft.	none from frost
Port Angeles	P.	yes	...	24 in.	none
Snohomish	M.	lay to curb	g.	2 ft.	.....
Tacoma	M.	no	...	24 in.	.....
Walla Walla	M.	no	...	2 ft.	those not in use deteriorate quickly

Table II—Water Works Services

Note: In the table, ci. means cast iron; cl., cement lined; gl., galvanized iron; gs., galvanized steel; gwi., galvanized wrought iron; i., iron; ll., lead lined; s., steel; wi., wrought iron.

Municipality	Materials used for services	Average life before renewal years	Cause of deterioration	Clogging of service pipes—Does it occur?	Clogging of service pipes—Method of removal
Arizona:					
Clifton	s.	2-20	corrosion by acidity from copper ore mill tailings used in surf. sts.	no	
Douglas	l. under pavt. s., earth	gs. 15	rust, elect., sediment	yes	renew
Glendale	gwi., l. large goosenecks	15-20	rust	no	
Nogales	gs.	15	rust	no	
Prescott	wi.	18	rust	no	
Tucson	l. under pavt. gi. otherwise	g. 20	rust	no	
Arkansas:					
Helena	l.	g. 15, black pipe 10	action of cinders and rust	no	
Russelville	g.	12+		no	
California:					
Anaheim	g.	20	rust	sediment	flushing
Benicia	l. under pavt. wi. otherwise		rust	no	
Burbank	wi., s.	wi. 35, s. 15	rust	no	
Calexico	wi.	8	destruction by soil	no	
Daly City	g., wi.	20		no	
Dinuba	s.	13+		no	
El Centro	l. serv.		rust from alkali	no	
Fort Bragg	wood	25			
Fullerton	l. on g.	8-20	elect.	no	
Monterey and 3 others	g.	20-25	rust	small pipes	renew
National City	wi.	10-30	rust from alkali	sometimes with meter	clean meter
Needles	wi.	5	rust	no	
Oxnard	wi.	20	rust	no	
Palo Alto	s., wi.	10-20	rust	no	
Red Bluff	g., wi.	40+	rust on outside	no	
Redding	s., ci.	s. 20, ci. 50+	rust of steel pipe	no	
Salinas	wi.	15	rust	yes, from sand	opening main and flushing
San Fernando	s.			no	
Santa Maria	ci., wi., s.	25	hardness of water	tuberculation	removal
Santa Paula	s., wi.	15-25	liming up	yes	renewal
So. Pasadena	g.			no	

Municipality	(P) or municipal (M) plant.	Are they required by city?	Services laid preparatory to paving, before needed for use. Kind of pipe specified.	Depth specified.	Trouble experienced with them after laying.	Cause of deterioration	Clogging of service pipes—Does it occur?	Clogging of service pipes—Method of removal
Salineville	M.	yes	l.	2 ft.	Clog by being kinked			
Shelby	P.	yes	l.	4 ft.	none			
Struthers	P.	yes	⅝ x½ ferrule l. to curb box	4 ft.	due to careless work			
Toronto	M.	yes	l.	42 in.				
Troy	M.	yes	l.	4 ft.	none			
Urbana	M.	yes	l.	3½ ft.	none			
Wauseon	M.	yes	l.	42 in.	none			
Wilmington	P.	yes	l.	3 ft.	none			
Oklahoma:								
Blackwell	M.	no		22 in.	none			
Clinton	M.	yes	l.	2 ft.	none			
Commerce	M.	yes	l.	24 in.	none			
Durant	M.	yes	l.	24 in.	none			
El Reno	M.	yes	l.	18-30 in.	none			
Guthrie	M.	yes	l.	18 in.	none			
Henryetta	M.	yes	l.	30 in.	none			
Hominy	M.	yes	l.	20 in.	none			
Jay	M.	yes	l.	36 in.	none			
Marshall	M.	yes	wi., l.	18 in.	none			
Norman	M.	yes	¾ l., 1.	24 in.	none			
Oklahoma City	M.	yes			none			
Okmulgee	M.	yes	l.	24 in.	none			
Sapulpa	M.	yes	l. or wi.	18 in.	few l. burst, some service rusted out			
Oregon:								
Eugene	M.	no		30 in.	Clogging with rust			
Grants Pass	P.	no						
Hood River	M.	yes	g.	30 in.				
La Grande	P.	no			none			
Marshfield								
North Bend	P.	no		18 in.				
Roseburg								
Pennsylvania:								
Ambler	P.	no		3 ft.				
Beaver	P.	yes	l.	3-4 ft.	wiped joints leak			
Bradford	M.	yes	l.	3½ ft.	none			
Clearfield	P.	no						
Elizabethtown	P.	no		3½ ft.				
Knoxville	M.	yes	wi.	4 ft.	none			
Lebanon	M.	no	l.	3 ft.				
Parkesburg	P.	yes	none	4 ft.	none			
Rankin	distrib-uting	no						
Ridgway	M.	yes	wi.	4 ft.				
Sewickley	M.	no	l.	4 ft.	break if laid on sour ditch			
Tarentum	M.	no		4 ft.	none			
Waynesboro	P.	no		below freez.				
West Newton	P.	no	none	3 ft.	none			
Rhode Island:								
Narragansett	P.	no	none	5 ft.	very little			
Wakefield								
Peace Dale	P.	no			rust, causing leaks			
Providence	M.	no						

Table II—Water Works Services—(Continued)

Municipality	Materials used for services	Average life before renewal years	Cause of deterioration	Clogging of service pipes—Does it occur?	Clogging of service pipes—Method of removal
Colorado:					
Brighton	i.	.....	.....	no	.....
Delta	wi.	15	alkali	no	.....
Denver	l.	40	erosion, corrosion, expansion of pipe	yes	pumping
Montrose	g. and l.	i. 15	alkaline soil	no	.....
Sterling	l. now	wi. 10-12	rust	no	.....
Connecticut:					
New Britain	g., wi., l. corp.	20	.....	no	.....
New London	brass, l., gi., ll	g. 12	elect., rust, soil action	yes	force pump
Florida:					
De Land	s., wi.	15	rust	.....	.....
Fort Myers	l., wi.	wi. 8-12	rust	some	.....
Lakeland	g.	.....	.....	seldom	remove joint, dry, rap on it
Quincy	wi.	20	breaking and tearing up	no	.....
Georgia:					
Cedartown	wi.	6-20	rust	no	.....
Newnan	s.	12-15	pitting and rust	no	.....
Idaho:					
Blackfoot	gi.	.....	.....	.....	.....
Burley	redwood and fir	.....	dry rot	some roots from trees	take out corp.
Caldwell	g.	.....	.....	.....	.....
Coeur d'Alene	g.	20	rust	no	.....
Lewiston	g. wi., l. goose-necks	30 g.-15 black	rust	.....	.....
Montpelier	g. wi.	15+	.....	no	.....
Preston	g., l. gooseneck	10+	.....	no	.....
Weiser	g., l. under pav.	g. 15-20	rust from alkali in soil	no	.....
Illinois:					
Hinsdale	l.	.....	old wiped joints breaking elect. in ci.	some at gooseneck	cleaned, with acid or new serv.
White Hall	l.	25+	.....	no	.....
Indiana:					
Franklin	wi.	18	elect., rust	very little	.....
Portland	l.	indef.	.....	some	air compressor and tank
Princeton	g.	15-20	rust, sediment	not much	.....
Richmond	l.	.....	elect.	no	.....
Rushville	ll.	20	rust	yes	renew
Seymour	wi. and l.	.....	.....	no	.....
Shelbyville	gs.	.....	none	no	.....
Iowa:					
Albia	l. and i.	.....	2 cases of elect.	.....	.....
Cedar Falls	wi.	.....	rust	no	.....
Charles City	l.	.....	.....	iron rust	flush hydrants
Cherokee	l., g.	.....	no elect.	no	.....
Nevada	l.	g. 8-20	elect. in loam, rust in clay soil	2 or 3 cases	renew
Newton	l., g.	g. 8-10	rust	no	.....
Oskaloosa	l. and s.	s. 12-20 wi. 20, l. 100	action of soil	.....	blow offs
Winterset	s.	gs. 14	rust	no	.....
Kansas:					
Augusta	wi. and l.	wi. 10	corrosion	no	.....
Baxter Springs	g. and l.	g. 20	rust	no	.....
Concordia	wi.	s. 20. wi. 25	1% or less	no	.....
Council Grove	s., wi.	s. 10-25	rust or corrosion	no	.....
Holton	wi., l.	wi. 10	rust	no	.....
Junction City	wi., l.	wi. 25	elect.; rust	no	.....
Manhattan	l. and wi.	.....	elect.	.....	.....
Pratt	s., l. under pav.	s. 7-15. l. 30-40	none	no	.....
Kentucky:					
Georgetown	g.	25	corrosion	no	.....
Hickman	s., wi.	7	rust	yes	renew or hore out with machine
Hopkinsville	g., l.	g. 30	rust	no	.....
Maysville	wi., l.	25-35	none	sometimes	.....
Paris	gs., wi.	20-25	.....	no	.....
Maine:					
Calais	wi.	30	elect., rust	some	pressure pump
Gardiner	wi.	15-20	rust	no	.....
Rockland	g., wi.	25	rust	yes	wiring
Rumford	g., wi.	12	rust	yes	cleaning rods
Maryland:					
Baltimore	ll. wi.	20	elect., rust	no	.....
Massachusetts:					
Adams	g.	30-50	rust	no	.....
Dalton	wi.	35+	none	no	.....
Falmouth	g., wi.	15	rust	yes	.....
Fitchburg	wi., cl.	50	rust	.....	run pipe inside
Lynn	wi., cl.	20-40	rust	no	.....
Millbury	cl., s.	.....	.....	no	.....
Shrewsbury	cl.	.....	.....	.....	.....
Michigan:					
Coldwater	l.	20+	.....	some	with water ram
Grand Rapids	l.	.....	.....	.....	.....
Hancock	ci.	.....	none	no	.....
Iron Mountain	wi.	wi. 30, s. 5	rust	.....	.....
Royal Oak	g., wi.	.....	.....	seldom	flush back into main with pressure pump
St. Joseph	g. wi., l goose-neck	.....	elect.	no	.....

Table II—Water Works Services—(Continued)

Municipality	Materials used for services	Average life before renewal years	Cause of deterioration	Clogging of service pipes—Does it occur?	Clogging of service pipes—Method of removal
Minnesota:					
Alexandria	l., i.	.....	rust	very little	.....
Fairmont	l.	.....	.....	.....	.....
Litchfield	g.	.....	.....	.....	no
Moorhead	l.	.....	elect.	few cases	run wire cable through pipe
New Ulm	l.	.....	.....	no	.....
St. Peter	s. and l.	s. 15-20	rust	no	.....
Mississippi:					
Charleston	wi., l. goosenecks	10	rust	no	.....
Tupelo	g.	20	.....	no	.....
Missouri:					
Chillicothe	s., l.	2-25	Corrosion and pitting	some	.....
Fulton	l. to curb box, s. or wi.	s. 15	rust	no	.....
Montana:					
Bozeman	g. wi., l.	g. 20	rust	no	.....
Havre	l.	g. 10	rust, splitting of pipe on seam	no	.....
Kalispell	l., g.	l. 50, g. 20	rust and corrosion	no	.....
Lewistown	l., g.	g. 8-12	rust and corrosion	no	.....
New Hampshire:					
Newport	cl.	25-35	rust	no	.....
New Jersey:					
West Orange	l., g. wi.	wi. 15, l. 25+	elect.; wi., inward corrosion	only in small pipes	renewal
New Mexico:					
Deming	gs.	15	rust	yes	renew
Tucumcari	gs.	15	rust	no	.....
New York:					
Little Falls	l.	35+	.....	no	.....
Medina	l. and s.	s. 15	rust	no	.....
Oneida	l.	indef.	none	no	.....
Owego	wi.	30	rust and filling up with inside deposits	.....	.....
Potsdam	s.	15-20	elect.	yes	force pump
Tonawanda	l.	.....	.....	.....	.....
Whitehall	g. wi.	wi. 10	rust and nature of soil	yes	flushing
North Carolina:					
Concord	wi.	15+	rust	some	renew
Elizabeth City	wi.	12-15	rust and settling from old filters	.....	.....
Henderson	s.	15	.....	some	usually renew
Kinston	g. wi.	30	rust	no	.....
Washington	g.	20	rust	no	.....
North Dakota:					
Bismarck	l.	g. 15-30	rust	no	.....
Mandan	l.	g. 3-7	none from l.	no	.....
Minot	l., ci.	.....	.....	no	.....
Ohio:					
Bellevue	wi.	15-25	mostly corrosion	no	.....
Bowling Green	l., s.	s. 15	elect. l., rust and elect. s.	no	.....
Celina	l.	indef.	.....	yes	air tank
Conneaut	g.	20	rust	no	.....
Delaware	wi.	20	rust	no	.....
Dennison	l.	.....	.....	no	.....
Greenville	l.	30	elect.	yes	dig up and clean ferrules
Leetonia	l. at main and g. wi. to curb	.....	.....	.....	.....
Logan	g.	.....	rust	yes	blow them
Marietta	g.	20-25	corrosion and rust mostly	no	.....
Middleport	wi.	.....	corrosion	no	.....
Oberlin	l., g.	wi. g. 25-30, gs. 5-15, l. 35+	wi. and s. from rust	yes	clean l. with hydrochloric acid
Ravenna	g. wi.	15	rust	small pipes	renew
Salineville	s. and l.	s. 20, l. 25	rust and elements in water	some rust and bends	renew
Shelby	l.	s. 5, l. 10, l. indef.	rust	.....	.....
Struthers	optional with prop. owners	.....	gs. rusting out	some	force pump
Toronto	l.	.....	elect.	yes	renew
Troy	l., wi.	20	rust, corrosion	yes	renewals
Urbana	wi., l.	.....	.....	no	.....
Wapakoneta	l.	.....	.....	corp. cocks only	bore out
Wauseon	l.	indef.	poor workmanship, wiped joints where used	no	.....
Wilmington	l.	20+	.....	no	.....
Oklahoma:					
Blackwell	cl., l., g.	g. 10	rust	no	.....
Clinton	l.	20	.....	no	.....
Commerce	s.	6	rust	no	.....
Durant	l. under pav., gs.	gs. 18, l. indef.	rust	no	.....
El Reno	l.	g. 20, l. 30+	.....	small pipes	renew
Guthrie	l.	10	elect.	no	.....
Henryetta	s. and l.	s. 4	.....	no	.....
Hominy	s. and l.	5	rust, action of soil	no	.....
Madill	g.	20	rust	no	.....
Miami	wi.	20+	.....	no	.....
Norman	wi.	12	rust	no	.....
Oklahoma City	l.	gs 15-20, l. 20+	.....	no	.....
Okmulgee	l.	.....	.....	no	.....
Sapulpa	l. under pav., s.	s. 7-10	rust	no	.....

Table II—Water Works Services—(Continued)

Municipality	Materials used for services	Average life before renewal years	Cause of deterioration	Clogging of service pipes—Does it occur?	Clogging of service pipes—Method of removal
Oregon:					
Eugene	g.	.....	rust	.....	.....
Grant's Pass	s.	25	rust	no	.....
Hood River	g.	.....	.....	no	.....
La Grande	g.	.....	.....	no	.....
Marshfield, North Bend, Roseburg	gs.	.....	rust occasionally	some	rod out
	g.	.....	rust	no	.....
Pennsylvania:					
Ambler	g. wi.	15	elect., rust	.....	.....
Beaver	wi.	24+	lead joints blowing out from pressure	no	.....
Bradford	l.	old pipe, 20-30	.....	.....	renew with l.
Clearfield	l. and g.	g. 25, l. more	corrosion	yes	renew
Elizabethtown	l., wi.	wi. 20	elect., rust	no	.....
Knoxville	wi.	.....	.....	no	.....
Lebanon	l. and wi.	i. 30 days-30 yrs., l. 50	.....	no	.....
Parkesburg	wi., s.	25	closing up or corroding	not much	take out
Rankin	l.	20+	elect., defective joints	no	.....
Ridgway	wi.	20	rust	no	.....
Sewickley	l.	.....	none	no	.....
Tarentum	wi.	12	.....	no	.....
Waynesboro	wi., l.	wi. 20-35	closing up	some	renewal
West Newton	wi.	15	rust	no	.....
Rhode Island:					
Narrag'sett Pr, Wakefield, Peace Dale	l.	30+	.....	yes	force pump
Phenix	gs.	15-20	rust in services	no	.....
Providence	l.	50+	.....	no	.....
South Carolina:					
Chester	g., l. connection	15-20	rust	no	.....
Sumter	g.	15	rust	yes	with jointed rods
South Dakota:					
Rapid City	l.	indef.	.....	no	.....
Watertown	l.	old g.-20	rust	no	.....
Yankton	l.	.....	.....	no	.....
Tennessee:					
Clarksville	l.	indef.	few cases of elect.	no	.....
Covington	l. and i.	.....	.....	some	.....
Dyersburg	l. and s.	l. 30, s. 15	rust	no	.....
Fayetteville	l., g.	20+	rust	no	.....
Jackson	i., l.	.....	rust	yes	rodding
Johnson City	g.	3-4	elect., rust	no	.....
Texas:					
Bryan	g. wi.	10-12	rust	no	.....
Childress	ci.	.....	rust	yes	water pressure
Clarksville	ci.	18+	.....	no	.....
Corpus Christi	l.	wi.-20	.....	no	.....
Del Rio	wi.	10	rust	no	.....
Eastland	wi. and l.	.....	.....	no	.....
Galveston	l.	.....	acid soil, elect.	no	.....
Georgetown	s.	20	rust	no	.....
Gonzales	ci., wi.	indef.	wi. rusts due to soil	.....	.....
Gorman	l.	.....	none	no	.....
Greenville	wi. and l.	.....	.....	no	.....
Longview	wi. and l.	wi. 10, l. indef.	rust	no	.....
McKinney	s., l. under pav.	s.-20	rust	no	.....
Navasota	i. and l.	i. 15- l. indef.	no	.....	.....
Orange	l. and g.	g. 12	rust on seams	no	.....
Weatherford	l., s.	s. 5-20	rust on acct. of soil	no	.....
Utah:					
Brigham	g., l. gooseneck	40+	none	no	.....
Vermont:					
Bennington	l.	34+	frost	no	.....
Brattleboro	wi.	30	elect.	no	.....
Washington:					
Aberdeen	gs.	12-15	rust on acct. of soil	interior rust of s. pipe	relay pipe
Anacortes	g.	15-20	rust, acid in soil	slightly	remove with wire
Auburn	g.	.....	.....	small pipe	.....
Bellingham	l.	.....	elect.	.....	careful flushing
Ole Elum	g.	15	.....	yes	force pump
Dayton	g.	33+	.....	no	.....
Ellensburg	g. wi.	.....	.....	no	.....
Hoquiam	wi., l. under pavt.	wi. 5-15	salty tide land and elect.	no	.....
Port Angeles	g.	20	rust	yes	air pressure, tank or pump
Snohomish	g.	20	rust	.....	.....
Tacoma	wi.	20	rust mostly	.....	.....
Walla Walla	g.	30-40	elect.	no	.....

Automobiles Break Hydrants

The year 1921 saw an unusual number of hydrants broken by automobiles in Waltham, Mass. The report of the department of public works of that city states that the water division was kept busy during the year replacing hydrants run into by automobiles. A number of the hydrants in the city are of a type such that, when the hydrant is broken off at the surface of the ground, the main valve is opened allowing the free escape of water from the mains. In one case it was necessary to close eight gates on large mains before the discharge of water from a broken hydrant could be stopped and in the meantime approximately 300,000 gallons of water escaped as a geyser in the street. The city is replacing this type of hydrant with another which, when broken, will not allow the water to escape.

Recent Legal Decisions

RIGHT OF MUNICIPALITY TO REMOVE PERMANENT OBSTRUCTIONS PLACED ON SIDEWALK

The city charter and ordinances of the City of Duluth make it unlawful for any person to place obstructions upon its sidewalks which interfere with public travel. In an action by a jeweler to restrain the city from removing a clock and the standard upon which it was erected on a sidewalk, the Minnesota Supreme Court holds, Mueller v. City of Duluth, 188 N. W. 205, that the municipal authorities may summarily cause such an obstruction to be removed, and that an application for a temporary injunction restraining them from doing so was properly refused. The fact that the city has permitted similar obstructions to remain in the street for a considerable time does not operate as an abandonment of the right of the public to its removal if it is an obstruction. Such an obstacle on the sidewalk, which obstructs travel thereon, cannot be regarded as a mere encroachment, so as to make its removal unlawful except upon the decree of a court of equity.

TIME FOR BEGINNING WORK HELD VITAL ELEMENT OF PAVING CONTRACT

The time for beginning work, definitely fixed by a paving ordinance, containing a penalty clause for noncompletion on a certain day, is held to be as much a vital element of the contract and specifications referred to in the ordinance as the time of completion, and tax bills for the work were held void where it was not even begun until after the date fixed for completion. A subsequent ordinance, extending the time for completion, was held to be void because unauthorized and without any valuable consideration.—Parker-Washington Co. v. Field, (Mo. App.) 239 S. W. 569.

CITY NOT LIABLE FOR FALLING WINDOW PANE, UNLESS WITH NOTICE OF ITS INSECURE CONDITION

The Missouri Supreme Court holds, Rice v. White, 239 S. W. 141, that a city was not liable to a pedestrian for injuries caused by a pane of glass falling from a business building in the absence of evidence that the window pane was insecurely fastened, or that it had become loose, and not even on such evidence, unless such condition was known to the city or its agents, or, upon a proper inspection, might have been known to them. A city's obligation to maintain its streets in a reasonably safe condition for public travel does not mean that its agents must enter abutting premises and closely examine all fastenings of window panes. The court quoted Leary v. City of Yonkers, 95 App. Div. 126, a case growing out of the falling of a sign over the street, maintained by a property owner, to the following effect: "It would impose altogether too heavy a burden to hold that the agents of the defendant, in such a case as this, were bound from time to time to enter the premises of the owners or occupants of lands along the streets, and make a close examination of signs or other projections extending over the highway, for the purpose of ascertaining whether or not they were in a safe condition."

MEASURE OF DAMAGES ON REFUSAL TO PERMIT CONTRACTOR TO COMPLETE CONTRACT

The Washington Supreme Court holds, Davis v. Thurston County, 205 Pac. 840, that where the complaint in an action by a contractor for damages for the refusal of the county to permit him to complete his contract did not seek any recovery for profits he would have made had he been permitted to complete the contract, an instruction permitting him to recover lost profits was erroneous. In such a case, the contractor, it is held, would be entitled to recover such proportion of the whole contract price as the amount of the work done by him before the contract was terminated bears to the whole amount of work to be done by him under the contract. For example, if he has completed one-half of all the work to be done, he would be entitled, under this rule, to recover one-half of the contract price. "To fix the amount of recovery by a contractor as 'the amount of his expenditures,' * * * or the reasonable value of the services performed, as held by some cases, would often work a great injustice. Under either of those rules a contractor might recover all or even more than the whole contract price, even though he may have done but half the work contracted for, or, on the other hand, he might be deprived of recovery for such profits as he may have made during his partial performance."

ABANDONMENT OF CONDEMNATION PROCEEDING FOR STREET

When the charter permits a city to abandon a proceeding instituted by it to acquire private property for a public street, the Minnesota Supreme Court holds, Mc. Rostie v. City of Owatonna, 138 N. W. 52, that the city may do so within the time prescribed without incurring liability to the owner for his voluntary acts in changing the condition of the premises by the removal of buildings thereon after the award of the commissioners is filed and prior to the abandonment of the proceeding. Where there has been such abandonment the possession and right of possession of the owner has never been interfered with. The mere entry to make and work a proper survey, doing no other injury to the property, does not give a cause of action.

ASSESSMENT OF SPECIAL BENEFITS FROM PARK IMPROVEMENTS

The Minnesota Supreme Court, In re Improvement of Lake of the Isles Park, 188 N. W. 54, regards it as too firmly settled to admit of dispute that acquiring land for a public park, fitting it for open-air recreation, and adding to its appearance by planting trees, shrubbery and flowers are all local improvements of special benefit to private property in the neighborhood. It holds that whether certain additions to a public park are of special benefit to property in the neighborhood is a matter of opinion on the facts as they appear, and the judgment of the body charged with the duty of ascertaining and assessing benefits will not be disturbed by the courts unless reasonable men could not have arrived at the same conclusion honestly.

NEWS OF THE SOCIETIES

CALENDAR

July 27-28—SHEET METAL CONRACTORS' ASSOCIATION OF PENNYLVANIA. Convention. Hotel Lawnce, Erie, Pa. Secretary, W. F. Anermeyer, 714 Homewood Ave., Pittsirgh, Pa.

July 26-28—WISCONSIN STATE ASOCIATION, NATIONAL ASSOCIATION F STATIONARY ENGINEERS. Conntion and mechanical exhibit. Capil Building, Madison, Wis. Chairman, nvention committee, J. J. Novotny, 33 Fox Ave., Madison, Wis.

Aug. 15-17—LEAGUE OF IOWA UNICIPALITIES. Annual meeting. ecretary, F. G. Pierce, Marshalltown,

Aug. 15-18—INTERNATIONAL ASOCIATION OF FIRE ENGINEERS. iftieth convention. Municipal Auditrium, San Francisco, Cal. Secretary, mes J. Mulcahey, Chief, Yonkers, Y., Fire Dept.

Aug. 28-Sept. 2—NATIONAL SAFEY CONGRESS. Detroit, Mich.

Aug. 29-30-31—LEAGUE OF CITIES F THE THIRD CLASS IN PENNSYLANIA. Annual convention, Williamsrt, Pa. Fred H. Gates, Secretary; ilkes-Barre, Pa.

Sept. 11-15—ASSOCIATION OF IRON ND STEEL ELECTRICAL ENGIEERS. New Auditorium, Cleveland, io.

Sept. 12-15—NEW ENGLAND WAER WORKS ASSOCIATION. 41st anial convention. New Bedford, Mass. ecretary, Frank J. Gifford, Tremont mple, Boston, Mass.

Sept. 14-16—AMERICAN ASSOCIAON OF PORT AUTHORITIES. Conntion at Toronto. Secretary, M. P. nnell, Jr., Montreal.

Sept. 25-28—SOUTHWEST WATER ORKS ASSOCIATION. Annual conntion. Hot Springs, Ark.

Oct. 1-6—AMERICAN SOCIETY FOR UNICIPAL IMPROVEMENTS. Annual nvention. Cleveland, Ohio.

Oct. 16-19 — AMERICAN PUBLIC EALTH ASSOCIATION. Annual meetg. Cleveind, Ohio.

Nov. 15-16—NATIONAL INDUSTRIAL EAGUE. Annual meeting. New York ty. Secretary, J. H. Beck, Chicago.

Dec. 7-13—NATIONAL EXPOSITION F POWER AND MECHANICAL ENNEERING. New York City.

MERICAN SOCIETY FOR TESTING MATERIALS

The twenty-fifth annual convention was ld at Atlantic City on June 27th.

The wide range of activities of the ciety made the holding of semi annual eetings imperative and it was suggested at one meeting be held in June for conleration of standards and tentative ndards and another be held in midnter for the consideration of testing d research.

The total membership was estimated 3,030, showing an increase of 122 for last year.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

The American Engineering Council of Federated American Engineering cieties announce the election of the folving officers of the American Institute Electrical Engineers: President, F. Jewett of New York; Vice-Presidents, Faccioli of Pittsfield, Mass.; Prof. W. I. Slichter of Columbia University, R. F. Schuchardt of Chicago, H. W. Eales of St. Louis, and H. T. Plumb of Salt Lake City; Managers, H. M. Hobart of Schnectady, N. Y., Ernest Lunn of Chicago, and G. L. Knight of Brooklyn; Treasurer, George A. Hamilton of Elizabeth, N. J.; Secretary, F. L. Hutchinson of New York.

TECHNICAL SOCIETIES PLAN PUBLIC WORKS BOARD

A plan for including a state board of public works in the new constituiton of the State of Missouri has been prepared by the Associated Engineering Societies, a chapter of the American Institute of Architects and the contractors, all of the city of St. Louis. The plan provides for directors of utilities, highways, water works, and conservation and board president to be appointed by the Governor of the State and to have supervision of activities in five divisions.

The division of structures will include land, natural resources, structures, equipment and improvements in which the state is interested.

The division of utilities includes maintenance, equipment, operation and service of all public utilities owned or operated by the state and the adjustment of rates and charges therefor.

The division of highways includes construction, maintenance, reconstruction and inspection of all public highways and bridges.

The division of water works will include waterways, watersheds, stream pollution, water works, irrigation projects, water power development, drainage and sanitary matters.

The division of conservation will deal with the conservation of resources, state planning and public safety.

The united support of engineers and contractors is invited for advocating the incorporation of the board of public works in the revised constitution.

THE ENGINEERS' SOCIETY OF PENNSYLVANIA

The following officers were elected at the recent annual meeting: President, Theodore E. Seelye; First Vice-President, Robert W. Moorehead; Second Vice-President, William Brown, Secretary, Howard E. Moses; Treasurer, Harry T. Neale.

THE ARKANSAS CHAPTER OF THE AMERICAN ASSOCIATION OF ENGINEERS

F. J. Herring addressed the meeting held recently at Little Rock, on the Salt Lake Convention and an address on the work done along the Mississippi Levee was made by L. R. Parmelee. An inspection was made of the Broadway Bridge across the Arkansas River.

PERSONALS

Harmon, W. W., has been appointed city engineer and ex-officio superintendent of streets of Oakland, Cal.

Allen, Joseph, Shell Lake, Wis. has been appointed County Highway Commissioner of Washburn County, Wis.

Condon, Russell, well-known public works contractor and President of the Omaha Chapter of the Associated General Contractors of America, died at the age of 52.

Ferris, John, has resigned from the position of State Highway Commissioner of New Jersey.

Wievel, George, city engineer of Platteville, Wis., died recently.

Baird, W. L., has resigned as superintendent of the city water works of Moberly, Mo. He is succeeded by Sam Duncan of Marshall, Mo.

Bickley, Creighton D., has been appointed highway construction engineer of Essex County, N. J.

Closson, Edgar S., general supervisor of bridges and structures, New Jersey State Highway Department, is now associated with the Lynch Construction Co., of New York.

Plato, E. J., has been appointed city purchasing agent for Sacramento, Cal.

Corcoran, C. J., has been appointed superintendent of water works, for the city of St. Helena, Cal.

Govette, A., has been appointed superintendent of roads for Longuille, Quebec, Canada.

Spear, R. E., has resigned from the position of city engineer of Ambridge, Pa.

Swandon, Melvin O., has been appointed superintendent of the Water and Light Board of Jamestown, N. Y. He succeeds Lyman P. Hapgood who is now chief consulting engineer.

Wright, G. E., formerly assistant engineer with the city engineering department of Bridgeport, Conn., is now engaged in a similar capacity at Gloversville, N. Y.

Russell, Walter C., sanitary engineer of Flint, Mich., has resigned and will accept a similar position with the city of Richmond, Va.

Pollack, James R., assistant city engineer of Flint, Mich., has resigned.

Nice, Everett W., has been appointed city engineer of Flint, Mich., succeeding E. C. Shoecraft, resigned.

Kearney, Stephen, city engineer of Lowell, Mass., since 1911, has resigned.

Lovis, A. M., formerly first assistant engineer of the highway division of the Massachusetts Dept. of Public Works, died recently.

Earle, W. C., has been appointed city engineer and superintendent of streets of Pasadena, Cal.

Wymer, Ralph W., has been appointed sewage-disposal plant engineer at Barberton, Ohio, succeeding E. B. Patterson, resigned.

New Appliances

Describing New Machinery, Apparatus, Materials and Methods and Recent Interesting Installations

A GASOLINE SUMMER TRAIN

The gasoline summer train is the very latest development of light equipment for railroad service. A two car unit of this type, manufactured by the Four Wheel Drive Auto Co. has just been completed. The cars are of the open type with adjustable side curtains, and each seat provides ample room for five grown persons. The forward car of this unit has a seating capacity of 35 persons and the rear car can accommodate fifty.

The cars are equipped with air brakes, electric starting devices and horn, standard MCB couplers, locomotive type "cowcatcher" on the forward car, sanders for sanding the rails, and high speed reverse gear which enables the cars to go as fast in reverse as they will go forward.

On short line railroads and especially on electric lines over which excursions are run in the summertime, the gasoline railway summer train is recommended for reducing operating costs and at the same time maintaining reliable transportation service.

GASOLINE TRAIN FOR SUMMER EXCURSIONS.

During the test runs which have been made with this equipment a speed of between 35 and 40 miles per hour has been attained. The cars have rounded curves up to sixteen degrees curvature at a speed of 25 miles per hour, without the least trouble and are capable of rounding much sharper curves at a reduced speed.

CALCO AUTOMATIC DRAINAGE GATES.

A bulletin describing the application of Calco flap gates to the ends of corrugated pipes, drains and culverts to protect the outlet of the discharge pipes, especially in draining projects for 79,000,000 acres of land in the United States reclaimable by drainage. Illustrated by several views of the gates fully or partially submerged.

The special features of the gate are the double hinge and great flexibility of bearings which have sufficient play to permit the movement of the valve by water pressure from behind not only at the bottom but at the top also, so that the gate offers very little obstruction even to the pipe flowing full of water. The valve and gate are accurately machined to insure water tightness and the motions of opening and closing grind away rust, dirt or other obstructions, keeping them in good working order. They are built by the California Corrugated Culvert Co. for pipes 80 to 14 inches in diameter.

WEAR PROOF SIGNS

Union Iron Products Co., Chicago, Ind., 6x9 inches, 24 pages, catalog to guide state, county or city officials in the selection of proper street signs for highway markers, describes and illustrates standard signs and poles, providing legibility, durability and attractiveness. The letters are countersunk in heavy metal and are either brightened or renewed with special rollers. Special road signs, house numbers, push brooms and zoning paint for marking safety zones on the pavements are also listed.

REINFORCED CONCRETE PIPE

Large diameter reinforced concrete pipe designed to withstand high pressure is manufactured by the United Concrete Pipe Co., which issues specifications and details of important points of its construction in sizes of 24 to 84 inches in diameter. Up to 48 inches, inclusive, the pipe is reinforced by a single ring of American Steel & Wire Co.'s triangle mesh and above that size by two rings placed about 1½ inches from the inner and outer surfaces. The pipe is made in standard sections having a uniform length of 4 feet and a thickness varying from 3 to 8 inches, which provides for a telescopic joint flush with both interior and exterior surfaces of the pipe. The length of the joint varies from 3 to 4½ inches and it is filled with cement mortar, into which the reinforcement projects.

Pipe of this type was laid for the city of Syracuse, New York, where 81 pieces, 60 inches in diameter inside and 20 feet long, formed a sewer outfall into Lake Onondago. Each piece had a thickness of 6 inches, contained 6.4 yards of concrete, and weighed 13 tons. They were concreted at the rate of two per day by a gang of from 18 to 25 men. They were poured, stripped, steam cured and revolved from vertical to horizontal position after they were four or five days old, stored, and subsequently they were rolled down inclined skids and launched, towed to position, sunk by admitting water ballast, and assembled by a derrick boat and diver.

"LITTLE GIANT" PIPE WRENCH

The "Little Giant" Pipe wrench, a new wrench with several interesting improvements has just been put on the market by the Greenfield Tap & Die Corporation. It has the "end opening" feature which is familiar to users of machinists' wrenches.

Its advantage over the conventional style is the ease with which it can handle pipes in corners, close to walls and similar confined places. The person using it can set it straight on the pipe as he would a pair of pliers, instead of having to fit the jaws on from the side.

The "Little Giant" wrench has only three parts; a handle and jaw in one piece, which is drop forged and heat treated, a movable jaw likewise drop forged and heat treated and a hardened steel nut. There are no springs, rivets frame or pins, all these parts being eliminated. In spite of the absence of spring this wrench takes hold and releases instantly at the option of the user.

The 14-inch size has repeatedly withstood stresses in excess of 4,700 inch pounds without slipping or bending. The army and navy departments require a test of 2,800 inch-pounds for a wrench of this size.

Another feature is the double set of teeth on the main jaw. The movable jaw can be engaged at the option of the operator with either of these sets of teeth with consequent lengthened life. On the large sizes, 14 inches and greater, two additional sets of teeth are provided, making four in all, and the movable jaw can be reversed to engage these additional sets of teeth, which are below the adjusting nut. This is very useful in connection with certain classes of work, besides practically quadrupling the life of the tool. The "Little Giant" wrench is manufactured in 8, 10, 14, 18 and 24 inch sizes, of which the three smaller sizes are already on the market.

PUBLIC WORKS.

CITY COUNTY STATE

A Combination of "MUNICIPAL JOURNAL" and "CONTRACTING"

Vol. 53 July 29, 1922 No. 5

Enlarging Harrisburg Filtration Plant

New sedimentation basin with some novel features, and anchoring new influent and effluent flumes to sides of old basin. New intake protected from needle ice and ice jams, with steam-heated grating at entrance. Also new filters and head house.

The city of Harrisburg, Pa., obtains its water supply from the Susquehanna river and, although the supply is abundant in quantity, it presents in quality some objectionable features peculiar to streams of this section, the most important being the large amount of coal dust that is brought down from the coal mines further up the river, clay turbidities running up to 3,000 pp. m., and sewage pollution. Filtration is necessary and has been employed for many years.

The fine coal carried down by the river has its advantageous as well as its objectionable features, in that deposits of it in the river bed all along the stretch in the vicinity of Harrisburg are used as a source of fuel supply for industries of the vicinity, including the Harrisburg pumping plant. Fine coal brought down by freshets and by the ice in the spring is deposited all along the channel of the river and is dredged out, screened and sold at a price lower than coal direct from the mines. Prior to the war this so-called "river coal" sold for considerably less than $1.00 a ton but now brings about $1.50. Having a specific gravity little heavier than water, the fine coal passes in considerable quantities into and through the pumps which lift the water into the sedimentation basin. Here the low velocity permits the sedimentation of a large part of the suspended matter, but it seems to be impracticable to entirely prevent the finer particles from reaching the rapid sand filters.

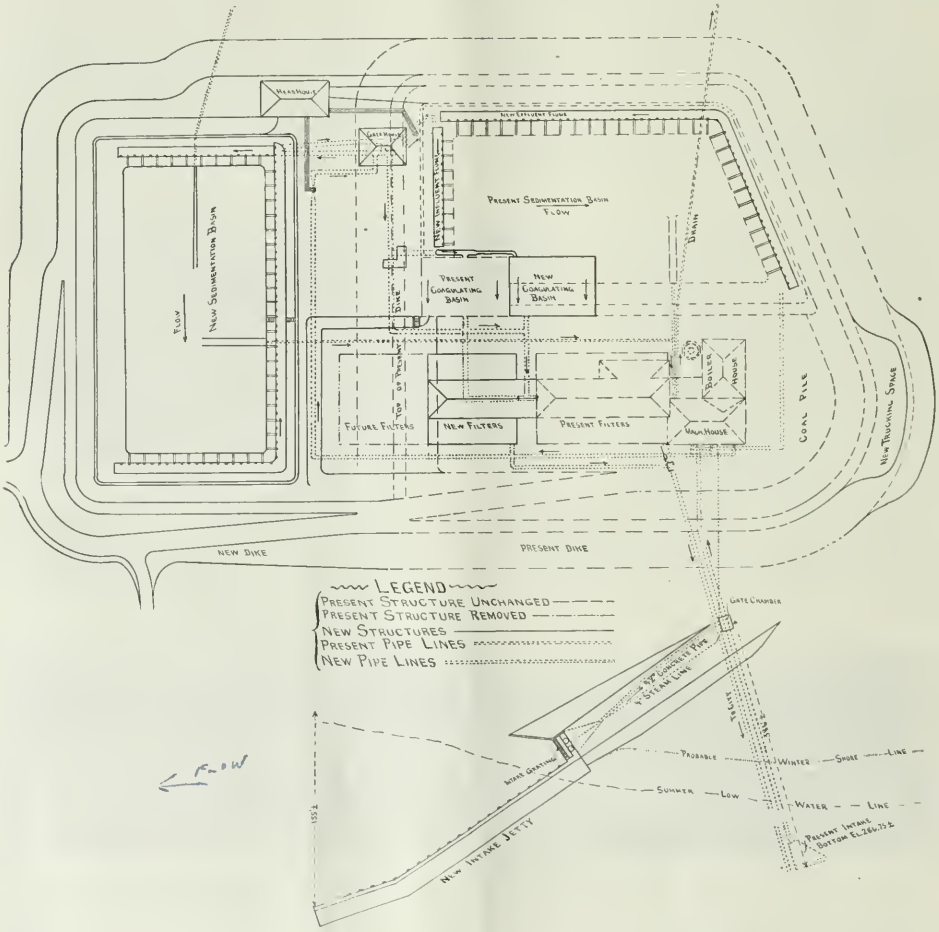
The plant built several years ago consisted of twelve filter units each with a nominal capacity of 1,000,000 gallons per day; a clear water basin underneath these filters; a sedimentation basin, coagulating basin, and pumping plant for raising the river water into the basin. The entire plant is located on an island adjacent to public athletic grounds. As a protection from high water, the plant is surrounded by a levee, the outer slope of which is paved with concrete. The filtered water passes from the clear water basin through a 42-inch pipe under the river to the main pumping plant on the main land opposite the island, known as the Front street pumping station.

In October of last year bids were received for additions to the water works, the work being let under four contracts. Contract A for Extensions to the Water Purification Plant, awarded to Whiting Turner Construction Co., of Baltimore, Md., consists of 8 new filters, a filter house, head house and gate house, new sedimentation and coagulating basins, a secondary intake for winter use and new pumping units. Contract B, for enlarging the main pumping station on the mainland and installing two new 15 M. G. D. turbine-driven centrifugal pumps, with boilers and accessories; contract C for a half-mile of 46-in. cast iron pipe; and contract D for a new athletic field to replace one, the site of which was required for the filter plant, are not described in this article. The entire work will cost $800,000.

GENERAL VIEW OF NEW SEDIMENTATION BASIN.
In the background, effluent flume, with intake openings. At the right, concreting the upper tier of panels of slope lining. At center of right-hand wall is concrete chute. The fourth panel to the right has been placed and is being screeded.

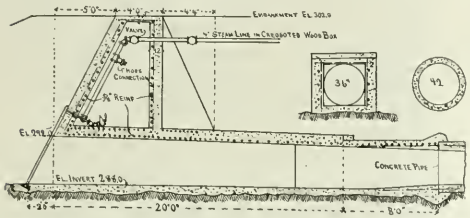
One of the features of the extensions a little out of the ordinary is the new intake and the jetty provided to protect it. The intake pipe is 42 inches in diameter, of reinforced concrete and extends for about 150 feet from the present intake pipe, which it joins at a gate chamber. Considerable difficulty has been experienced in the past with needle or slush ice entering the intake and ice jams which fill the entire river channel with broken ice, allowing but a small passage of water through them. With a view to preventing this and also to protecting the intake from outgoing ice in the spring, the intake pipe is covered with an embankment, the pipe and embankment extending about to the line of summer low water. The up-stream slope of the embankment is paved with concrete. The end of the intake will be covered with a grating to keep out large floating matters. The upstream face of the embankment that covers the intake pipe will be extended by an intake jetty of concrete; the line of intake pipe, embankment and jetty making an angle of about 30 degrees downstream with the line of the river. The concrete jetty will be about 250 feet long and will create quiet water behind it in front of the intake pipe and thus permit needle ice to float upon the surface and prevent its entrance into the intake pipe. It will also give a better means of drawing water from the ice jams.

The intake jetty will be constructed of a series of slabs of reinforced concrete, each slab being 9 feet long, 3 feet wide and 10 inches thick; these slabs resting upon piers of reinforced concrete with the upstream face having a slope of 45 degrees and the downstream face a batter of 1 in 8. These piers are spaced 10 feet apart on centers and are connected by a top deck consisting of a concrete slab 3 feet wide and 2 feet thick, as well as by the slabs beforementioned which rest upon their upstream edges,



GENERAL PLAN OF HARRISBURG WATER PURIFICATION PLANT, SHOWING EXTENSIONS AND CHANGES.

there being 7 slabs connecting each pair of piers. Slots are left between the slabs in order to reduce to a minimum any differences in elevation of the water on the upstream and downstream faces. This jetty rests upon rock in the river which has only a shallow covering of earth, and has an average height of about 12 feet. The piers are built of 1-2½-4½ concrete and the slabs of 1-2-4 concrete. Each pier is anchored to the rock by a number of steel rods one inch square, which are carried 3 feet into the rock and the same distance into the piers.



VERTICAL SECTION OF INTAKE CHAMBER AND MANHOLE.

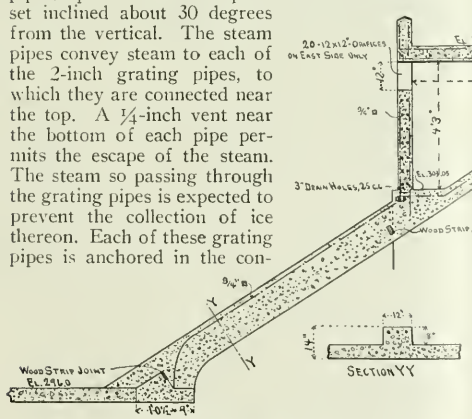
A 4-inch steam line encased in a 12" by 12" timber box, which also contains four 1-inch pipe lines to operate the hydraulic valves at the intake, is carried from the boiler plant over the dike and to the intake, the steam line being continued to the river end of the intake. By means of the hydraulic lines it will be possible to open and close the valves controlling the two intakes during high water when the river will be several feet above them.

The reinforced concrete intake pipe ends in an intake chamber which is funnel-shape in plan, 4 feet high from invert to roof, 15 feet long, and 20 feet wide at the outer end, and is roofed over with reinforced concrete. The concrete pipes were made by the Lock Joint Pipe Co., with cast iron ends and lead expansion joints. Above the end of this intake chamber is a manhole, into which the 4-inch steam line passes, where it termintes in two lines of 2½-inch steam pipe which extend out to the grating, which is formed of 38 extra-strong wrought iron pipes, spaced 6 inches apart center to center and set inclined about 30 degrees from the vertical. The steam pipes convey steam to each of the 2-inch grating pipes, to which they are connected near the top. A ¼-inch vent near the bottom of each pipe permits the escape of the steam. The steam so passing through the grating pipes is expected to prevent the collection of ice thereon. Each of these grating pipes is anchored in the concrete bottom of the intake chamber and extends above the top of said chamber.

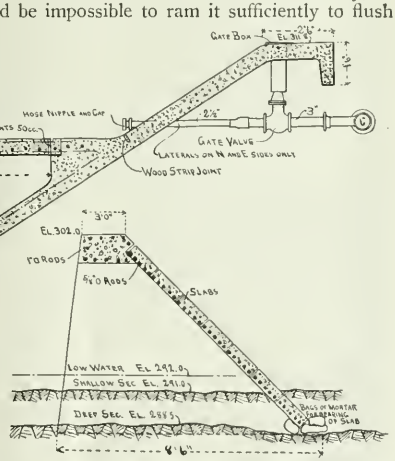
The new sedimentation basin will be 236 feet long by 114 feet feet wide at the foot of the slope and 16 feet deep. The banks will rise 24½ feet above the bottom of the reservoir at the higher end, the opposite end being a foot and a half lower in order to permit draining it. The basin is rectangular with the corners connected by curves having a uniform radius of 3 feet from top to bottom.

A flume surrounds the reservoir on one side and both ends, that at one end serving as an influent flume while that on the other end and one side serves as an effluent. This flume is built in the form of a hollow bench about half way up the sloping sides of the reservoir, the vertical face and horizontal top, with the sloping basin lining, giving it a triangular shape. In the face of the influent flume there are 25 rectangular openings 9 inches by 10 inches, set with their bottoms 10 feet below the water surface. Similar openings but 12 inches by 12 inches in area and 20 in number are built in the outlet flume, being set with their bottoms 4½ feet below the water surface.

The sides of the reservoir have a slope of 1 on 1½ and are faced with 6 inches of concrete mixed 1-2½-4½. The lining is laid in three tiers, each being built in alternating slabs 7 feet wide. In constructing the first slabs, a one-inch wooden strip is used as a form, and in filling in the spaces, these strips are left in place to serve as expansion joints; the swelling of the wood by absorbing water being relied upon for keeping the joints water-tight. The concrete is mixed on top of the bank and is discharged through a chute which drops it approximately where wanted, although it is necessary to rehandle it by shovel. After the concrete for a slab has been deposited and roughly faced, it is screeded off and a surface of cement mortar is applied and troweled down to a smooth finish. Owing to the slope, the concrete has to be mixed rather dry, as it would be impossible to ram it sufficiently to flush



SLOPE LINING AND EFFLUENT FLUME, SEDIMENTATION BASIN.



SECTION OF INTAKE JETTY.

the mortar to the surface without at the same time causing it to slide down the bank; hence the necessity of applying the thin mortar surface, which is done as soon as the concrete is in place.

In order to drain the sedimentation basin to permit cleaning it or for other purposes, a gutter is constructed in the bottom leading to an 18-inch reinforced concrete pipe. This gutter has a fall of one foot in the length of the basin. Thirty-three two-foot lengths of halves of 24-inch steel pipe are to be set over the gutter, convex side up, as covers to prevent the sediment from filling the gutter and the blow-off pipe. In cleaning the reservoir, when the sediment has been removed up to and from around the end cover, this cover is lifted, and so on with each successive cover until the entire basin has been cleaned, when all the covers will be replaced preparatory to putting the basin in service again.

The present sedimentation basin is also to be provided on three sides with flumes similar to and having the same dimensions and general construction as those in the new basin. In order to tie the flumes to the old basin lining, the old lining is to be broken through at numerous points along horizontal lines corresponding to the connection of the top and bottom walls of the flume with the lining. Along these lines 12 by 12-inch openings will be broken in the lining at intervals of 5 feet and the earth excavated beneath such openings to a depth of about a foot, and two ½-inch anchor rods inserted in each hole to tie the flume concrete to the anchor concrete which is rammed in each of these holes and made monolithic with the concrete of the flumes. A new concrete facing is also to be placed on top of the old lining in the flume. Struts 8" x 12" and 12 ft. c.c. extend from the bottom of the flume to the bottom of the basin, a distance of about 11 feet. At the junction of the struts and the bottom lining of the basin, holes similar to those above are broken through the old lining to provide anchorage. This flume in the old basin will have openings or ports similar to those in the new basin. The existing flumes have become damaged and at present water enters the old basin at two points only and the full width of the basin is not effective, there being an area of slack water between the two inlet openings.

A new head house is to be built at one corner of the new sedimentation basin and near the old basin, and the water from the pumps will pass near this and receive chemicals from it before entering either basin; a gate house nearby permitting control of the flow of the water to either or both basins by means of hydraulicly operated valves. The levee or embankment extends level with the second floor of the head house where the chemicals will be stored and thus furnishes opportunity for delivering them directly to the storage floor without the necessity for using bucket elevators or other similar contrivances generally necessary. A new concrete road is being built on top of the dike.

Between the basins and near the head house there exists a coagulating basin, and a new coagulating basin will be constructed adjacent to this.

Immediately adjacent to the old filters, eight new filters will be placed similar to the old ones, with a clear water well beneath them. Excavation for the clear water well goes down to and 2 ft. into rock and thus furnishes solid foundation for the clear well, filters and superstructure. The new filters will occupy a space 70 feet long by 65 feet wide and 9 feet deep. The clear water well extends to a further depth of about 11 feet.

CONCRETE CONSTRUCTION

The pavement on the slopes and bottom of the sedimentation basin was poured in blocks each of about 50 square feet area. Between the blocks were placed strips of white pine or poplar ⅞-inch thick and extending 2½ inches down from the surface, the wood strip being set at the time of pouring the first block adjacent to it and being kept absolutely dry up to that time. Similar strips are placed between the floors and walls of the coagulation basin and the filtered water basin and between the walls of the coagulating basin and the floor of the sedimentation basin.

The concrete pavement for the outside of the dike and the floor of the coagulation basin has no wood strips, but is provided with steel reinforcement.

Another requirement connected with the concrete construction is that, in the case of the filtered water basin and the supports for the filters overhead, the transverse arches and the piers supporting them are to be built monolithic, as are the flat longitudinal arches supporting the filters, each of the latter being separated from its fellows over the center lines of the piers by a space one inch thick at the top and ½-inch thick at the bottom and reaching down from the top to a depth of 10 inches, using metal covered strips to secure this result. These strips are to be removed about 24 hours after the concrete has been placed on the entire set of four filters. After they have been removed and the centers have been eased, such amounts of thin grout will be poured into the spaces previously occupied by the strips as may be directed by the engineer, and the balance of the spaces will then be filled with Portland cement mortar mixed one part cement to two parts sand, placed in layers 2 inches thick and tightly tamped with heavy iron tampers; this packing to be mixed dry and tamped as tightly as possible.

The superstructures of the filter house, head house and gate house are being built of red brick to match in color, size and texture those in the existing filter house. Window sills are of Portland cement concrete.

FILTERS

Each filter is to contain two troughs for distributing the raw water and removing the wash water, which will be constructed of sheet steel channels and flanges, covered with steel pipe coating. . Each trough is 26 feet 9½ inches long and increases at a uniform rate from 14 inches inside diameter at one end to 18 inches inside diameter at the other, and from a height of 10 inches at one end to 12 inches at the other. The trough is supported by two 3-inch 5-pound channels, one along each upper edge, while the channels themselves are supported by the walls at the two ends, and at four intermediate points by suspender rods of ⅜-inch galvanized steel, 4 feet 5 inches long, the upper ends of which are fastened to concrete beams spanning the top of the filter.

The underdrainage system consists of a manifold

of 1¼-inch wrought iron pipes extending each way from the center, where they are screwed into 1¼ by 1¼ by 2-inch tees. These tees are connected to a large cast iron manifold which connects with a 14-inch cast iron pipe suspended from the underside of the filter floor. These 1¼-inch pipes are spaced 6 inches between centers. Each pipe carries holes 7/32 of an inch in diameter and 3 inches apart, in a line located exactly at the bottom of the pipe, for the entrance and exit of filtered and wash water. Each filter contains 54 pairs of these small pipes or laterals, which will be so set in place, supported on wooden blocks, that all shall be in the same horizontal plane, and cement is then placed around them near the ends and the center, but so as not to close any of the holes, the wooden blocks being left in place until the cement is thoroughly set. This drainage system, it is seen, is a very simple one. It is required that all wrought iron pipe used in the filters be genuine wrought or puddled iron.

Each filter is 16 feet by 27 feet and 9 feet deep from top of floor to underside of roof. The greater part of the filter extends outside of the walls of the superstructure, where it is roofed over, the opening within the superstructure and adjacent to the pipe gallery being 5.5 feet wide.

The filters are arranged in the customary manner, in two rows one on each side of the central pipe gallery, which is 15 feet wide.

Portable sand ejectors are to be provided, each consisting of a hopper constructed of No. 12 B. W. G. galvanized steel plates riveted to a 1 by 1 by ¼-inch angle at each corner, this resting on a cast iron base into which are screwed nozzles which form the ejector apparatus. The whole is mounted on 8-inch by 1½-inch oak planks, the base being 27 inches by 22 inches out to out. Near the tops of the hoppers are fastened two forged steel handles for carrying the sand ejectors. The top of the hopper is 22 inches square and the entire ejector apparatus is 21 inches high. The outer end of each nozzle carries a female brass swivel hose connection, 2½-inch on the inlet end and 3-inch on the outlet. The end or throat of the outlet nozzle is made of chilled cast iron.

Underneath the filters is a filtered water basin which is 69 feet long and 64 wide, extending from out to out of the filters. The roof of the basin is formed of concrete arches, which support the floors of the filters and are themselves supported by short piers 3 feet square that rest on bed rock. The basin is 9½ feet high from top of floor to underside of the crown of the roof arches. The bottom of the reservoir is about 3½ feet below summer low water in the river. The spaces between the haunches of the arches and the underside of the filter floors are to be filled with sand deposited in water before the construction of the filter floors is begun, so as to secure a perfectly solid support for such floors. The walls and arches of the filtered water basin are of heavy concrete without reinforcement, but the floor, walls and roof of the various filter units are of reinforced concrete.

The orifice box carries in the bottom a bronze orifice plate with an opening 8¾ inches in diameter, in which plays vertically a bronze "needle" (so-called) which is in shape similar to a plumb bob with a maximum diameter of 8.24 inches, or slightly less than that of the opening. This needle is fixed to the end of a vertical bronze shaft one inch in diameter. The shaft and the needle attached to it are raised by the revolving of a bronze gear wheel, in the threaded center opening of which plays the threaded portion of the needle shaft. By connection with the operating table, the needle can thus be raised or lowered from there at will.

DIKE ENLARGEMENT

As before stated, a dike surrounds the entire plant to protect it from floods in the river. This is wide enough for a drive, but not to permit the turning of the trucks that are used for bringing coal to the pumping plant. There is under construction an additional width to the embankment at a point opposite the coal pile, giving a total width of 35 feet for a distance of 100 feet at this point to permit the turning of the trucks. The slope of this new embankment also is paved. In order to prevent the sliding of the new fill over the surface of the old slope paving, this latter was broken through along horizontal lines 5 feet apart measured along the slope pavement. In these holes were driven 2 by 4 stakes at right angles to the slope, which project about 6 inches above the concrete and which carry on their upper surface 1 by 6-inch boards, the lower edges of which rest upon concrete slope pavement. The holes through the pavement were then filled with 1-3-6 concrete, the outer part of which was struck off to a horizontal surface. These form horizontal steps along the old slope pavement at intervals of 5 feet, the purpose of which is to prevent the new earth fill from sliding on the surface of the old slope pavement.

James H. Fuertes was retained to enlarge the plant, which he built seventeen years ago, on substantially the lines of the original plant. F. H. Weed is resident engineer in charge of the filters, and Jepita A. Wade is in charge of the Front street pumping station and force mains. The work herein described is being done by the Whiting-Turner Construction Co., of Baltimore, with John H. Merritt as superintendent in charge, and H. G. Campbell as engineer for the contractor.

Flushing the Sewers in Waltham

Waltham, Mass., has 47½ miles of sanitary sewers, including six inverted siphons. These serve an area of 3.1 square miles out of the total area of the city of 13½ square miles. However, the water mains serve only about 65 miles of street so that the sanitary sewers cover about three-quarters the street length reached by the water mains.

For flushing the sewers, 2½-inch hose connected to fire hydrants is used where there are hydrants within 100 feet of the flushing manholes. But 124 manholes are not so located and these are connected directly with the water mains to provide for flushing. In addition to flushing sewers, they are cleaned by use of ropes, chains, followers and scrapers of different kinds. During the year ending January 31st, 1922, there were 20 stoppages in the sewers.

Resurfacing Old Pavements*

Methods reported by city engineers for renewing or covering worn wearing surfaces of brick, stone block and wood block pavements.

Lakewood, Ohio, levels off the old base with a binder course and surfaces with sheet asphalt or asphaltic concrete.

In Middletown, Ohio, the old brick is first cleaned by sweeping and brushing and is then covered with a 1½-inch layer of crushed stone, 1½-inch size. Tarvia X is then applied, about one gallon per square yard followed by stone chips about ¾ of an inch deep. The pavement is then rolled with a steam roller. Tarvia X is then applied at the rate of about ½ gallon per square yard and covered with about ¼-inch of torpedo sand. Another application of ½ gallon per square yard of Tarvia X is applied and the pavement is rolled. After the street has been subjected to travel for three or four months, the surface is cleaned and a half gallon per square yard of Tarvia B is applied and the surface covered with torpedo sand and rolled.

Sandusky, Ohio, covers old brick pavements with 1¾ inches of sheet asphalt on a one-inch binder, after first filling depressions in the old brick pavement with additional binder and tamping it.

South Point, Ohio, either turns over the brick or covers the pavement with sheet asphalt.

Toledo, Ohio, does not believe in resurfacing over old brick pavements where the brick was not laid on a concrete base.

Washington Court House, Ohio, resurfaces with 1½ inches of sheet asphalt on a one-inch binder.

Wilmington, Ohio, covers the pavement with sheet asphalt.

Altoona, Pa., relays old brick pavement, turning the brick and supplying enough new brick to take the place of those that are entirely worn out. After removing the brick, uneven places in the base are leveled up with concrete and the brick is laid on a slag cushion. Where the brick has no salvage value, the city has been replacing old brick pavements with new reinforced concrete pavements, this also being done where the base is found to be in poor condition.

In Beaver Falls, Pa., old brick pavements are thoroughly cleaned and enough binder applied to restore the crown and are then covered with 2 inches of asphaltic concrete.

Chester, Pa., last year resurfaced one brick street with asphalt, the bricks being thoroughly cleaned with steel brooms and thoroughly painted with an asphalt coat. On this a 2-inch sheet asphalt surface was laid. Where this abutted an asphalt pavement, the latter pavement was cut back and, at the other end where it abutted a brick pavement, the bricks were removed for about 3 feet and the surfaces brought up with additional thickness of binder.

In Du Bois, Pa., in 1909, 17,000 yards of brick were resurfaced with 2½ inches of asphaltic concrete.

Franklin, Pa., uses sheet asphalt with a binder course on old brick pavement.

Greenville, Pa., contemplated resurfacing 25,000 square yards with sheet asphalt or warrenite.

Jersey Shore, Pa., resurfaced brick with K. P. and ¾-inch chips followed by screenings and dust.

Oil City, Pa., cleans the pavement and fills depressions more than one-inch deep with binder, then lays binder with one-inch minimum depth and a 1½-inch top of standard sheet asphalt.

Sewickley, Pa., uses 2-inch thickness of bituminous concrete.

Sharon, Pa., repairs broken base and deep depressions in the old brick surface with new concrete brought level to the surrounding surface, shallow depressions being filled with asphalt binder. The old pavement is thoroughly cleaned and covered with the usual thickness and mixture of sheet asphalt or asphaltic concrete.

Uniontown, Pa., in 1921, resurfaced 11,000 square yards of old brick pavement with tarvia macadam 2½ to 3 inches thick. After washing and sweeping the pavement, ½ to ¾ gallons of tarvia per square yard was spread and on this was placed about 3 inches of ballast size crushed stone, which was lightly rolled. About 1¾ to 2 gallons of tarvia per square yard was then poured and sufficient ½-inch to ¾-inch stone screenings were spread to fill all voids. This was thoroughly rolled with a 12-ton roller. All loose screenings were then swept up and ½ gallon of tarvia per square yard was poured and covered with a coat of 1/16-inch to ⅛-inch silica gravel and rolled until firm. Traffic was then admitted and after about 6 weeks of use the street was swept and ½ gallon of tarvia A per square yard was spread by pressure tank and this was covered with silica gravel and rolled. This street looks like sheet asphalt and is in a very satisfactory condition. It was anticipated that when warm weather arrived this summer it would be desirable to spread an additional thin coat of silica gravel to absorb any excess tar, as the weather was cold when the last coat of tar was applied last year. The total cost of material and labor for this work was $2.05 per square yard.

Wilkes-Barre, Pa., cleans out crevices in the old pavement and applies binder and sheet asphalt.

Wilkinsburg and Williamsport, Pa., have resurfaced with new brick.

Beaumont, Tex., uses from ½-inch to one-inch of Uvalde rock asphalt for covering old brick pavements.

Fort Worth, Tex., covers the brick with a flush coat of asphalt and lays 1½-inch of Uvalde rock asphalt.

Houston, Tex., uses 2 inches of Uvalde rock asphalt.

In Danville, Va., sheet asphalt is laid direct on the old pavement, the surface first being thoroughly cleaned by washing or sweeping and all depressions

*Continued from page 57.

filled with close binder to bring the pavement to an even surface. 1½-inch binder is used and 1½-inch top.

Norfolk, Va., lays 1¼-inch binder and 1½-inch sheet asphalt top.

In Parkersburg, W. Va., specifications for resurfacing brick pavements with sheet asphalt call for cleaning the pavement with steel brooms until the surface is absolutely clean, if necessary flushing with water until all joints are cleaned and then allowing to dry thoroughly. Depressions or holes are entirely filled with binder or concrete properly compacted in place, this material being paid for at a unit price per ton. If the gutter would normally be too shallow after applying the asphalt, the brick for a distance of 3 to 4 feet from the curb is to be taken up and replaced with concrete base. Catch basin screens or manhole covers are raised so as to conform to the new pavement surface, using bricks laid in mortar under the casting for this purpose. Following this, after the concrete has set, a binder course one-inch thick is laid and on this a surface course 1½ inches thick, using the specifications for sheet asphalt pavement; this being paid for at a unit price per square yard. The contractor is to guarantee the work against poor workmanship and material for six months after final acceptance.

In Oshkosh, Wis., brick pavement is generally resurfaced by turning the brick, replacing broken bricks with whole ones. About 6,000 square yards were covered last season with a mat of tar, roofing gravel and sand ½-inch thick.

In Milwaukee, Wis., old brick pavements are resurfaced by removing the brick and substituting a 3-inch asphalt pavement. In a very few cases the bricks have been turned, but this has not proven very satisfactory.

Appleton, Wis., uses tarvia in repairing old brick pavements.

STONE BLOCK

City Engineer Prann, of Meriden, Conn., does not recommend resurfacing on stone block, but would tear up the old block and relay it on the old foundation if this is of concrete.

New Haven, Conn., lays 1½-inch binder and 1½-inch top on old stone block. In some cases the blocks are removed and the additional thickness of pavement necessary to bring up to grade is made with an extra thickness of binder and the wearing surface is made 2 inches instead of 1½-inch.

Norwich, Conn., has covered some stone block streets with sheet asphalt.

Chicago, Ill., cleans out the joints between block and cleans the surfaces, then lays 1½ inches of binder covered with 1½ inches of sheet asphalt or asphaltic concrete.

Portland, Me., takes up stone blocks, recuts them and relays them on a concrete base with cement grout filler.

In Cambridge, Mass., stone block is usually recut and relaid on concrete base with cement grout filler.

Holyoke, Mass., either recuts and relays blocks or replaces them with concrete.

New Bedford, Mass., last year resurfaced 17,832 square yards of rough block pavement with one inch of bitulithic.

Newark, N. J., on heavy traffic granite pavements has used a 50-50 mixture of asphalt cement and sand. Heavy traffic streets have received this treatment with great success, and the method has been adopted by the state highway engineer for repairing some of the state highways.

Brooklyn, N. Y., recuts and relays granite blocks.

Greensboro, N. C., has resurfaced only stone block pavements with sand filler and has found it most satisfactory to take up the block, recut them and relay them with asphalt or cement filler.

Toledo, Ohio, usually resurfaces old medina stone pavements with 1½ inches or 2 inches of asphaltic wearing surface, using enough binder to give a minimum thickness of ½-inch and leave a uniform thickness of top or wearing coat. The old pavement is prepared for resurfacing by cleaning out the joints to a depth of ½-inch to 1 inch, raking them out with sharp pointed iron tools, then washing the pavement clean with hose. It is then covered with a close binder of asphalt surface prepared as for standard asphalt pavements.

In Parkesburg, Pa., stone blocks have been relaid in bitumen and surfaced with tarvia.

WOOD BLOCK PAVEMENTS

In Faribault, Minn., wood blocks have been covered with Tarvia B and sand about ¼ of an inch thick.

Cape Girardeau, Mo., has surfaced the old wood block streets with concrete 4½ inches thick reinforced with 34 pounds of fabric.

Altoona, Pa., has resurfaced wood block pavement by removing the blocks and grouting the old base to the true contour of the street and relaying the blocks on a thin bituminous coating, filling the joints with tar to a point 1/3 the height of the block, then filling flush with a filler of trap rock dust.

Wichita Falls, Tex., tore up about two blocks of wood block last year, painted the concrete base with asphalt and resurfaced with 4 inches of reinforced concrete. Also it treated about 40,000 square yards of wood block with ¼ gallon of Tarvia B in order to waterproof the blocks and prevent buckling.

(To be continued)

Cost of Horse Maintenance

In the annual report for 1921 of the Street Cleaning Department of Cincinnati, the superintendent, Fred Maag, gives as usual quite complete figures covering the operations of the department. Among these are those bearing upon the cost of the maintenance of the horses used by the department and the work done by them.

The horses are kept in 14 stables, there being altogether about 185 horses and 23 mules, 7 stables containing only 2 animals each. The average cost of feed in all the stables for the year was 39.3 cents per horse per day. The cost varied by months and

also in the various stables. For instance, averaging all the stables, the feed cost varied from a minimum of 32.7 cents in December to 46.9 cents in March. This variation is probably due largely to that in the unit cost of food during the year. Between the stables, however, the variation was even greater, the minimum daily average for any one stable for the year being 30.4 cts. and the maximum being 53.4 cts.

These costs are made up of the costs of hay, oats, nutritia, bran and oil meal. Averaging all of the stables and the entire year, the daily consumption per horse per day was 16.1 pounds of hay, 12.7 pounds of oats, 1 pound of nutritia (this was used in January only), about .0093 pounds of bran and .0011 pounds of oil meal. The bran was used only from September to December, inclusive, and the oil meal in January, April, June, September and November.

The idle time of the horses averaged (excluding Sundays) about 5.5 days per month, varying from a minimum of 4.8 in April to a maximum of 7.1 in August. The idle days ranged from a minimum of 30 per cent. in April to a maximum of 40 per cent. in July.

In addition to the cost of feed, the other stable expenses, by months, averaged from 50.4 cents per horse per day in January to 97.4 cents in April; giving a total stable cost per horse per day, averaging all stables, varying from 83.7 cents per horse per day in October to $1.419 in April. Allowing for idle time, this gives a total stable cost per applied horse day varying from a minimum of $1.355 to a maximum of $2.043.

The greater part of the horses were used in ash removal, nearly as many being so used in summer as in winter. For instance, the number of horse-days employed for ash removal was 2,324 in July while the maximum was 2,906 in March, with 2,891 in January. The horse-days used for removing street sweepings varied from a minimum of 833 in February to a maximum of 1,208 in October. The next largest use was in sewer cleaning, in which from 280 to 372 horse-days per month were used.

South Street, Philadelphia, Bridge Piers

Steel and timber caisson foundations rapidly sunk by open well dredging followed by pneumatic caisson excavation. Old cylinder piers removed by dredging and dynamiting. Superstructure cut up with oxyacetylene torches

The South Street highway bridge across the Schuylkill river, Philadelphia, was built in 1875-6 with one swing span 119 feet long center to center of rest piers, and two flanking spans of 189 feet from center of rest pier to face of abutment, all of them having wrought iron pin-connected trusses, designed for much lighter loads than those furnished by the present traffic, and having insufficient clearance for street cars and vehicular traffic on the swing span. The pivot pier was a braced cluster of 9 concrete-filled cast iron circular caissons, 4 feet in diameter except the center one which was 8 feet in diameter. The rest piers each had two 8-foot iron cylinders which, like those of the pivot pier, had been carried through sand, mud and gravel by the pneumatic process to bearings on rock at elevations varying from about 33 feet to 54 feet below datum, which is approximately 7½ feet above low water level. The superstructure was reinforced in 1897 and the piers were strengthened in 1895 by enclosing them with wooden cribs and building masonry around the cylinders.

It was recently decided to replace the old superstructure and its four piers by new construction of greater weight and capacity for highway traffic and affording more clearance for navigation.

New piers were therefore designed to clear the old piers and provide for a channel of 100 feet between the main piers, which support a two-leaf bascule plate-girder span, on each side of which there are two plate girder spans of 128 feet 6 inches and 97 feet 4½ inches from center to center of piers and from center of piers to bearings on old abutments, which are retained.

The work was designed to avoid interference with the city traffic for as long as possible, and the contract, including the removal of the old structure, was awarded to the Dravo Contracting Company, Pittsburgh, for $650,000.

No attempt was made to disassemble the old truss members, but these were cut into convenient lengths by seven oxyacetylene torches installed by the American Bridge Company, subcontractor for this work and for the fabrication and erection of the new superstructure. The old crib work was removed and the original piers were shown to be in a weak condition and damaged by vertical cracks probably caused by the freezing of water contained in them. The cylinders were cut off at the bottom of the dredged excavation, about 26 feet below low water level, by means of strings of dynamite cartridges contained in pieces of old hose pipe and tied around the cylinders by divers. The firing of these cut off the cylinders, which then were easily removed by tackles suspended from a very heavy A-frame installed on a scow and serving as a powerful floating derrick.

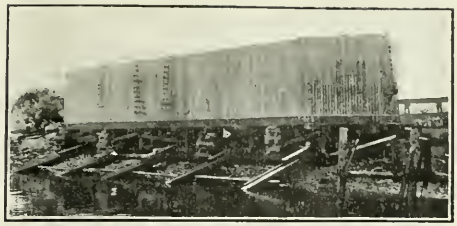
Pier No. 4, on the East side of the river, was built in dry excavation and piers Nos. 1, 2 and 3, in the river channel, were built by the caisson process. Pier No. 1, supporting the fixed spans at the West end of the bridge, has a caisson 15½ feet wide, 71 feet long and 50 feet high. The twin piers No. 2 and 3, supporting the bascule span, have duplicate caissons 26½ feet wide, 109 feet long and 40 feet high. They all have structural steel cutting edges and a steel plate roof over a working chamber 7 feet high, above which the walls are of timber in one 18-foot course and one 12-foot course surmounted by a detachable wooden 12-foot cofferdam.

The cassions differ materially from the usual structures of this type, as instead of being built extremely heavy, as has been the usual method, these are constructed with heavy steel working chamber and roof and the timber side sheeting is only heavy enough to stand the water pressure while handling and concreting the caissons. The concrete is of a rich mixture and heavily reinforced and carries the various stresses that such a structure is subjected to, whereas in the old type of caissons the extremely heavy timbering carried most of the stresses from handling and sinking.

The caissons were all built on shore, where they were constructed up to the top of the lower course, the roof plates and walls thoroughly caulked and launched on ship ways, floated, towed to position, moored to the old piers and sunk by concrete ballast until they took bearing on the bottom; after which they were undermined by orange peel buckets excavating through open steel wells 7 feet in diameter, five of which were provided for each of the large caissons and three for the small caisson. The mud flowed into the dredged pits sufficiently to permit the caissons to sink until they reached hard ground and cemented gravel, when it became necessary to continue the excavation by the pneumatic process.

Caisson No. 2 was sunk to hard stratum by open dredging in three days, and after conical reducers had been added to the tops of the 7-foot dredging shafts and surmounted by umbrella-type air locks, pneumatic pressure was applied and the caisson was sunk 7 feet farther through clay and 1 foot through cemented gravel by shifts of 25 sand hogs working in successive 8-hour shifts for 7 days. This excavation included the blasting of about 150 yards of rock and filling the working chamber with concrete.

Caisson No. 1 was sunk about 12 feet by dredging in two days, and in eleven days under air pressure 12 sand hogs per 8-hour shift (3,168 man-hours) sunk it 5 feet through cemented gravel, 2 feet through hard mud, and 3 feet through soft rock under a maximum pressure of 18 pounds. The



CAISSON WITH TIMBER SIDE SHEETING IN PLACE.

chamber was concreted in two shifts and was afterwards sealed by grouting.

All of the caissons were so thoroughly calked that they were almost absolutely watertight, and required no pumping. About 30 feet of concrete was filled in solid above the steel roof to sink the caisson to its required position, after which the upper section of the steel shaft was disconnected above the surface of the concrete and salvaged, forms were set up on top of the concrete and the remainder of the piers was concreted in the dry. It was expected that Pier No. 1 would be completed about July 1st and Pier No. 2 about July 15th.

The rock in the working chamber was drilled with 3 Ingersoll-Rand jack-hammer machines and was blasted with 60 percent dynamite.

The contractor was required to test the rock in each of the working chambers by taking out in Piers 1 and 4 two 3-inch cores each, and in Piers 2 and 3 six cores each, all of them eight feet long. Each core was made in about 5 hours by the Pennsylvania Drilling Company, which commenced operations in one part of the large caissons while excavating or concreting was going on in another portion of the same caisson. After removing the cores, 3-inch steel dowels, 12 feet long, were driven into each of the core holes, providing additional anchorage for the piers.

The principal amounts involved in the contract are about 2,000 yards of pneumatic caisson excava-

GENERAL VIEW OF SOUTH STREET BRIDGE, SHOWING OLD PIERS.

tion, 12,000 yards of dredge excavation and 1,200 tons of steel. The maximum force employed by the contractor was 75 sand hogs and 90 other laborers. Operations were commenced early in February and it is expected that the steel erection can be begun August 1st. The contractors have a time limit of 18 months for the completion of the job, but according to the present indications, they are ahead of the schedule sufficiently to finish the work six months ahead of time.

The principal plant installed includes one Dravo whirler derrick with 12-ton, 76-foot boom installed in the material yard and for caisson building; one 33 x 90-foot derrick boat with Dravo whirler; one concrete boat with 60-foot hoisting tower; 20 and 40-yard sand and gravel bins; a 1-yard Ransome mixer, and a Dravo whirler derrick with a 76-foot boom; one Merritt-Chapman 75-ton floating derrick installed by the subcontractor for the steel work; a battery of 3 Dravo vertical steam boilers with a combined capacity of about 200-HP operating one 22¼ x 24-inch and one 16¼ x 18-inch Ingersoll-Rand straight-line air compressors with a combined capacity of about 2,000 cubic feet per minute; two 60-hp. Dravo vertical boilers on the mixer boat; three 3-drum Lambert steam hoisting engines for the whirler derricks; one set of diving gear; a complete equipment of pneumatic tools; 3 material locks, 1 man lock and 1 concrete lock; five 7-foot steel dredging well shafts made in 7-foot sections by the Dravo Contracting Company; 5 reducing sections for dredge shafts; 3 Heyward orange peel buckets, one 1-yard and one 1⅝-yard Williams clam shell bucket handling coal and aggregate.

The work was designed under the direction of S. N. Noyes, bridge engineer, Department of Public Works, Philadelphia, and the substructure work was executed under the direction of R. G. Stowell, superintendent for the Dravo Contracting Company.

Fifth Bates Road Test

The fifth test run on the Bates road saw the failure of several more sections under the load of 6,500 pounds on each rear wheel. At certain places the pavement was broken to such an extent that the trucks were unable to travel through them, and these were replaced by novaculite. Practically every one of the lighter sections have completely failed under this or previous runs, although the heaviest load was well under the legal load allowed in Illinois.

The sixth run is being made with 8,000 pounds on each of the rear wheels and 1,930 pounds on each front wheel, which is the legal limit for Illinois. It is proposed to continue this load for 10,000 applications so that a thorough test can be made of all the remaining sections. This run is expected to extend over six weeks as the maintenance of the sections in passable condition will undoubtedly present a complicated problem.

DERRICK BOAT WITH WHIRLER DERRICK AND CONCRETE MIXER

The end of the fifth test saw the failure of the last section of the bituminous filled brick on macadam; three of the twelve sections of asphaltic concrete on cement concrete base; five of the thirteen of bituminous filled brick on cement concrete base; five of the seven of monolithic and semi-monolithic brick, and eleven of the twenty-seven cement concrete sections.

Most of the failures, however, had occurred during the earlier runs. The bituminous filled brick on macadam that failed in this run did so after the subgrade had been saturated, as had been done during the fourth run to the subgrade under a section of asphaltic concrete on macadam and under one of 4-inch concrete on a rolled stone base (see PUBLIC WORKS for July 8th). In addition to the complete failures a number of corner failures occurred during this run—7 in the asphaltic concrete pavement, 6 in bituminous filled brick on cement concrete, 3 in monolithic and semi-monolithic brick, and 10 in the cement concrete.

Baltimore Balancing Reservoir*

Constructed in Connection With the Raising of the Loch Raven Dam to Prevent Excessive Pressure on the Tunnel Connecting the Dam With the Purification Plant.

A so-called balancing reservoir has recently been completed in connection with the Gunpowder river improvements to the water supply of Baltimore. The reservoir was constructed as a means of limiting the pressure on the tunnel conducting water from the Gunpowder river to the city. The accompanying diagrammatic sketch shows the reservoir with respect to the other parts of the water works to which it is related.

A short description is necessary to explain the need for the reservoir.

The first Gunpowder works, which were completed in 1888, were composed of a low masonry dam across the river at Loch Raven, now known as the lower dam; Lake Montebello, and a tunnel 12 feet in diameter and 7 miles long from Loch Raven to Lake Montebello. The second Gunpowder works, which were completed in 1915 are composed of a low dam—now known as the upper dam—a filter plant, and a pumping station to raise water from the tunnel to the filters. With this new system of operation, the tunnel was subjected to an additional head of 17 feet, the difference in elevation between the upper and lower dams.

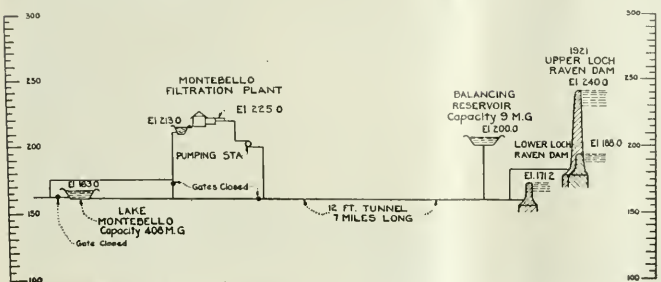
The upper dam has recently been raised from elevation 188 to elevation 240 above mean tide, and if the tunnel were strong enough to sustain the additional head, it would be possible now to supply the filters by gravity for most of the time and resort to pumping only when the water surface in Loch Raven reservoir dropped considerably below the crest of the dam.

The tunnel is 12 feet in diameter. For about six miles from the city end it is deep below the ground surface in hard rock free of seams and is unlined. For the remainder of its length, about 6,000 feet, the tunnel is much shallower, passes through mica schist and seamy limestone and is lined with brick. Pressure tests were made on the tunnel by closing the gates at Loch Raven dam and allowing water to pass back into the tunnel. The tests proved that the head on the tunnel can not be much increased without endangering its safety and causing excessive leakage. The tunnel might be strengthened by lining it with concrete, but can be spared from service only four days at a time, and we estimate that three years would be required for lining it throughout, during which period of successive watering and unwatering, pressures throughout the low service zone would change with every change of operation. Further, the city has been faced with a water famine with every dry year, so filling the large impounding reservoir as soon as possible takes precedence over all other water works consideration, and the city may not wait for a tunnel lining.

An outlet was provided in the new Loch Raven gate house for an additional tunnel, which should be built when the operating costs of the increasing pumpage equal the carrying charges on a new tunnel.

As the tunnel can not be operated under much additional pressure, means of relieving the pressure to be imposed by the high dam had to be found. If the entrance of water into the tunnel could be exactly regulated, the head could be maintained at that which the tunnel would stand; but the flow through the tunnel must vary from hour to hour with the fluctuating demands of the city, and the gate openings at Loch Raven cannot be adjusted to follow immediately the change in demand. Moreover, if a pump were thrown out of service, or the electric plant momentarily failed, throwing all the pumps out of service, pressure would rapidly build up in the tunnel.

*Paper before Am. Water Works Ass'n by Wm. A. Megraw, water engineer, Baltimore.



DIAGRAMMATIC SKETCH SHOWING BALANCING RESERVOIR IN RELATION TO OTHER PARTS OF BALTIMORE WATER WORKS

Water might be passed from the tunnel directly into Lake Montebello, thus avoiding increasing the pressure; but if this were done it would be necessary to discard the existing pumping station and install a new station on the shore of the lake to pump from the lake to the filters against a head fifty per cent higher than before.

It was noticed that water stood in an abandoned quarry, located approximately over the tunnel and about 4,300 feet from Loch Raven, which had been dry before the second Gunpowder works were built, and that the surface of this water rose when storm waters flowed over Loch Raven dam. The quarry occupied a natural depression in the hills, which might be converted into a reservoir by constructing a low dam and provide a water surface at elevation 200. This elevation would increase the head on the tunnel 8 feet and its carrying capacity to as much as the impounded river is estimated to furnish, and reduce the pumping head about one-fifth.

The function of a balancing reservoir is to supply the deficiency to the pumps when too little water is being admitted to the tunnel, and to absorb the excess when too much is being admitted.

The cost of the balancing reservoir was estimated to be about one-tenth that of a new pumping station. Plans were prepared and a contract was awarded to Thomas Mullen of Baltimore on September 10, 1921, for building the reservoir and appurtenances. All work was completed in April, 1922.

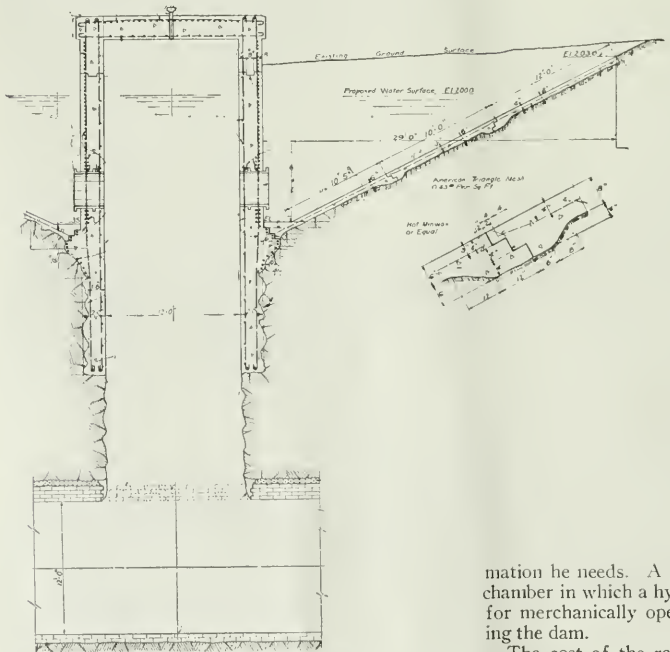
The reservoir is irregular in outline. The bottom is a natural clay overlying rock. The dam forming the closure in the hills is of earth taken from the bottom and sides of the reservoir and rolled in six-inch layers. The inside slope of the dam is one on three and the outside slope one on two. The inside slope is lined with concrete slabs.

A vertical shaft through soft rock provides communication between the tunnel and reservoir. The shaft is 12 feet in diameter and is lined with reinforced concrete. Six 36-inch diameter flanged openings are arranged radially around the shaft, their inverts at elevation 190, which is the elevation of the reservoir bottom. The dam is at the opposite side from the shaft and as the original ground surface sloped away from the shaft toward the dam, it was necessary to regrade a portion of the bottom, in order that the entire contents of the reservoir may empty through the shaft into the tunnel.

The greatest depth of water is 10 feet, so the entire contents is available with small variation in head. The capacity is about nine million gallons.

A concrete lined channel 20 feet wide at the bottom, having sloped sides, pierces a hillside beyond the dam to serve as a spillway.

The electric current feeding the pumping station is occasionally interrupted, whereupon the pumps run backwards and a shock is produced by the contact between the water moving forward in the tunnel and the water moving backwards from the filter plant. The contract provided for a second shaft 12 feet in diameter over the tunnel about 300 feet from the Montebello Pumping Station, with the top open and at elevation 201, to provide overflow and relief for the shock of surging waters.



SECTION OF TUNNEL, SHAFT AND PART OF RESERVOIR

On April 11, 1922, the relief openings in the new Loch Raven dam were closed, allowing the water to rise back of the dam. On May 6th the surface had risen to elevation 201, and gate regulation was then necessary to prevent water in the balancing reservoir wasting over the spillway. Gate regulation must continue until water overtops the Loch Raven dam, after which it probably will be desirable to set the gates, permitting a portion of the excess flow of the river to fall continuously over the spillway at the balancing reservoir, thus saving attendance and wear and tear of the gates. The height of water in the gate chamber back of the gates indicates the height of water in the balancing reservoir and a self-recording gauge gives the gateman all the information he needs. A turbine pit was left in the gate chamber in which a hydro-electric unit may be placed, for merchanically operating the gates and for lighting the dam.

The cost of the reservoir and appurtenances was approximately $60,000.

PUBLIC WORKS

Published Weekly
at 243 W. 39th St., New York, N. Y.

S. W. HUME, President J. T. MORRIS, Treasurer

Subscription Rates
United States and Possessions, Mexico and Cuba $3.00 year
All other countries..... 4.00 year
Change of Address
Subscribers are requested to notify us promptly of change of address, giving both old and new addresses.

Telephone (New York): Bryant 9591
Western Office: Monadnock Block, Chicago
A. PRESCOTT FOLWELL, Editor
FRANK W. SKINNER, Associate Editor

CONTENTS

ENLARGING HARRISBURG FILTRATION PLANT. Illustrated 77
Flushing Sewers in Waltham 81
RESURFACING OLD PAVEMENTS 82
Cost of Horse Maintenance 83
SOUTH STREET, PHILADELPHIA, BRIDGE PIERS. Illustrated 84
Fifth Bates Road Test 86
BALTIMORE BALANCING RESERVOIR. Illustrated 87
EDITORIAL NOTES 89
Public Works to Be Issued Monthly—Reducing Cost and Time of Caisson Work.
ACID TREATMENT OF WOOL SCOURING WASTE WATER 90
WOOD WATER MAINS 91
OPERATING SEWAGE TREATMENT PLANTS.. 92
RECENT LEGAL DECISIONS 94

Public Works to Be Issued Monthly

In the future PUBLIC WORKS will be published as a monthly, the next issue appearing on August 15, and the date of issue thereafter being the 15th of each month. This involves no change in the policy of the paper, but is made because we believe that, with more time available between issues for collecting, digesting and editing, we can promise our readers a more comprehensive and valuable publication than has been possible with the weekly issues, although we do not feel that any apologies for these are called for. And with the larger monthly issues we can give in each one matter of value and interest in every branch of public works and appealing to each class of our readers.

The August number, in addition to articles dealing with other phases of public work, will feature the subject of sewerage and sewage disposal statistics, concerning which data are being collected from city engineers throughout the country. No information of this kind has been compiled by any one since 1915, when Municipal Journal (the former title of this paper) gathered and published it. Seven years have elapsed since then, and no doubt most engineers and other city officials will be particularly interested in such data.

Reducing Cost and Time of Caisson Work

Caissons are necessary in excavating and concreting for a large amount of important substructure work both on land and water. Open caissons, which are essentially rigid vertical movable cofferdams, can be constructed much more easily, quickly and economically than equivalent pneumatic caissons, which are essentially diving bells and require slower, heavier and much more costly construction. Pneumatic caissons are often necessary for excavation in quicksand or in very hard or irregular or obstructed strata, while open caissons may be generally used in other cases.

Open caissons may be sunk much beyond the theoretical maximum depth for pneumatic caissons and the excavation in them is generally much more rapid and less costly. Concrete is also deposited in them more readily and cheaply than in pneumatic caissons and forms a mass monolithic with the superstructure, while in the pneumatic caisson, the body of the pier and its foundation are separated by the roof of the working chamber.

Often a large proportion of the excavation in open caissons can be made with mechanical plants such as dredging buckets, and in any event the work does not subject the men to the dangers always involved in work under pneumatic pressure.

When the open caisson cannot be unwatered and it is necessary to hand dress or inspect the bottom, it may be imperative to complete the excavation and execute part of the construction under pneumatic pressure. In such cases if all of the work is done with a pneumatic caisson it may be very slow and costly. The bulk of it, however, can be generally adapted to open caissons and can be done in the latter, while only a portion of the work, to complete the job, must be done in pneumatic caisson, thus providing a classification by which great saving of time and labor may be effected.

Within recent years this has been recognized in a number of important works by commencing excavation in open caissons that were designed to be eventually transformed into pneumatic caissons for the completion of the difficult portion of the work. This practice has been successfully carried out and practical features developed by the contractor for the substructure work described in this issue, who in this case built pneumatic caisson working chambers and surmounted them with open caissons and detachable cofferdams fitted with large-diameter open dredging wells through which the excavation was made with mechanical plant as far as the strata were suitable for this manner of sinking of the caissons; after which the dredging wells were closed, compressed air injected to expel the water from the working chamber, and the excavation was completed by the pneumatic process which was thus applied to only about 1/7 of the total excavation, obtaining the required final result much more quickly and cheaply than if all the work had been done by the pneumatic method.

Careful investigation and planning will often enable work to be designed so that a large portion of the preliminary operations may be carried out by the cheaper method of open caissons and the small remaining part finished by converting the open into pneumatic caissons if necessary, although if the conditions prove favorable the pneumatic caissons may not be required at all and the work may be finished with the open caissons alone. Ordinarily, very little extra cost is involved in constructing an open caisson in such a manner that it may quickly be converted at need into a pneumatic caisson, and practically no extra cost is required for building a pneumatic caisson so that it may be used at first as an open or dredging caisson.

Acid Treatment of Wool-Scouring Waste Water

South African town uses the acid process to prevent clogging of filter beds at disposal plants, and reduces fats from 11,430 parts per million to 75.

Considerable experimenting has been done in this country with acid treatment of sewage, especially that covered by the Miles patent; but in England it has been in actual use for a number of years. Apparently its use had not been adopted in its South African colonies, even for the direct treatment of factory wastes, until recently, to judge from a paper read before a meeting of the Institution of Municipal and County Engineers, held at Bloemfontein last month.

This paper was prepared by H. M. Ladell, town engineer of Wynberg, and the following synopsis of it is given by *Municipal Engineering and The Sanitary Record* of London, England.

Mr. Ladell stated that the problem of preventing damage to sewage plants by wool scouring liquor confronted him in 1919. In seeking a solution the only reference to the subject that he could find was in the reports of the Royal Commission on Sewage Disposal.

A large number of woolen manufacturers in England had soak and settling tanks, but in South Africa scarcely more than one such washery could be found in a town, so that the waste waters added little to the total sewage, and therefore it would not pay to put down works specially. On the other hand, the amount of fat in a single factory's untreated wool-scouring waste would destroy the working of an ordinary sewage farm. Consequently it seemed preferable to treat the waste at the factory. One washery turned its waste direct into the sewers, with the result that inlet channels were clogged with grease and the filter-beds and land injuriously affected. The factory owners had improved the effluent. The Royal Commission held that in the great majority of cases it was practicable for manufacturers to purify the waste by reasonable preliminary measures, and suggested clarification down to 6 parts of suspended solids per 100,000. In the case under notice an attempt was made at inexpensive removal of detrimental fat, irrespective of revenue from the substances. Analysis showed that the sud contained as much as 1143.0 parts per 100,000 of total fats. All fatty matters were classed as "free" or "combined," the first being traceable in alkaline effluent, the other in the acidified residual. Some change appeared to take place in the sewers, the effluent at the factory showing more free fat, whereas at the disposal works it showed more combined fat, possibly due to the formation of some weak acid and resultant decomposition. Therefore both must be dealt with effectively.

Wool scouring was usually done in three bowls, the wool being mechanically passed through each. Then it was rinsed in a fourth bowl, the water of which was not considered as containing fatty matter until analysis at Wynberg revealed 9.12 and 7.16 parts per 100,000 of total fats in it. Experiments showed the necessity of determining temperature of sud when adding acid, quantity of acid added, and temperature at skimming.

The sud was run off from the bowls into a collecting tank, then run or pumped into the "acid" tank, where acid was added. The sud, which was warm on leaving the bowls, should not be allowed to cool, otherwise the addition of acid caused sulphuretted hydrogen. The average period in the acid tank approached twenty-four hours; therefore the capacity of acid tanks should be equal to three times the daily flow. Before adding the acid the heat of the sud was increased by steam to 120 deg. Fah. The acid quantity was about 1 gallon of acid to 250 gallons of sud. The sud and acid should be thoroughly mixed and left to cool, when the fatty matters will rise to the surface and could be skimmed off. Skimming was a very important part of the operation and needed careful attention. Skimming by hand with a small scoop was the common method, but this was crude and liable to be inefficiently carried out. The draw-off from both acid and lime tanks should be by "floating" arms, so arranged as not to allow either the top or bottom layers of water to be taken, as both these generally contain fatty and solid matters. Careful working had shown that it is quite easy to reduce the "free" fats in the final effluent to 2 parts per 100,000 and the "combined" fats to 5½ parts or a total of 7½, and this is the maximum at present allowed. In each of the three tanks, *i. e.*, collecting, acid and lime tanks, a considerable quantity of sludge will be deposited. That in the collecting and acid tanks should be removed after each time these are used.

Outlets from all bowls or places where any washing of wool takes place should be so constructed that the whole of the water used must run into the collecting tank. There should be no outlet from the collecting tank except through the acid tank, and no outlet from the acid tank save through the lime tank, except in each case for sludge. The sets of tanks should be at least in duplicate. It was most difficult, if not impossible, to find any records of analyses of sewage showing the "fat" contents, and one could not judge what was a fair proportion to allow for.

Wood Water Mains

Advantages and disadvantages discussed by engineer of extensive experience, who compares wood and cast iron from points of view of life, serviceability and cost, concluding that where conditions are suitable for it wood is the more economical.

Wood was the first material used for water mains in this country and it is still used to a considerable extent, but cast iron has superseded it as the standard material for such service. In view of the fact that wooden water mains have been found in good condition after having been for a century or more in the ground and that such mains are considerably cheaper than cast iron in most localities, some engineers have naturally wondered why they have not come into more general use. A quite exhaustive and apparently unbiased discussion of wood water pipe was presented to the American Water Works Association at its latest convention by J. W. Ledoux, in which he makes a comparison between wood and cast iron pipe.

He states that cast iron pipe will last at least 100 years while the average life of wood pipe is not more than 25 years. "There are many modern wood pipes that have been giving good service much longer than 25 years, but when we compare it with cast iron it is best to assume the short life with the wood pipe." He then takes for comparison a line of 24-inch continuous redwood pipe. The discharging capacity he considers to be 20% greater than that of cast iron of the same size. According to the assumed life, the wood pipe would have to be renewed four times during the 100 years and cast iron not at all. Assuming 65 pounds working pressure, the initial cost of 10,000 feet of wood pipe would be $41,900 and of cast iron pipe $67,000 or, to obtain the same capacity, a larger cast iron pipe would be used costing $74,050. He assumes the cost of repairs to the wood pipe at 1% per annum and of cast iron pipe at 0.25% and the taxes in each case as .6%; giving the annual charge for wood pipe $670 and for cast iron pape $630. He compares the two pipes on the basis of present worth and gives the present worth of $41,900 at 5% for renewal in 25 years as $12,373, the same for renewal again in 50 years as $3,654, the same for renewal again in 75 years as $1,079 and for renewal in 100 years as $319. Also the present worth of the $670 annual charges for 100 years at 5% is $13,400. The present worth of the $630 annual charges for the cost iron pipe for 100 years amounts to $12,600. Adding to these the initial costs of $41,900 for wood pipe and $74,050 for cast iron pipe gives the total present worths of $72,725 for wood pipe and $86,650 for cast iron pipe. This shows a saving of nearly 19% in the use of wood pipe over the cost of cast iron pipe on the basis of present worths.

Making another calculation on the use of machine banded eastern pine wood, with an initial cost of $28,900, he obtains present worth figures of $50,125 for the wood pipe and $86,650 for the cast iron, a saving of $36,525. For larger sizes of pipe the difference would be greater, and for smaller sizes it would be less. For 12-inch machine banded eastern pipe the initial cost would be $14,600 as against $26,900 for cast iron pipe, or $29,070 to obtain the 20% greater capacity of the wood pipe. Calculating in the same way as above he obtains present worth of $25,847 for the wood and $34,027 for the cast iron.

"When a financial comparison on a rational basis shows such a material advantage of wood over cast iron pipe, the question naturally arises, why is cast iron so universally preferred by most of the leading engineers? It is, no doubt, because there have been so many unfortunate experiences with wood pipe. Successful installations cause only the same effect on engineering sentiment as does a moral scandal on that of the public; successes are forgotten and the failures vividly remembered.

"Then again, cast iron pipe is suitable for nearly all situations and conditions of operation under the widest range of pressure and flow, and even in the circumstances of distribution mains where the carrying capacity is reduced as much as 75%, its reputation for reliability and ruggedness is not destroyed the owners comforting themselves, where they happen to know about it, with the feeling that they can always restore the capacity by cleaning. On the other hand, there are frequently conditions that would give no trouble with cast iron pipe where wood pipe would be entirely unsatisfactory. It must be admitted that most of the wood pipe companies are coming more to realize these facts, and of late years refuse to furnish pipe where the conditions are unfavorable. Wood pipe is sometimes shipped before needed and left out exposed to harmful weather conditions, causing warping and permitting dirt to get into the stave joints. In some important installations, sap and knotty wood has been used which adds further to its discredit."

Mr. Ledoux believes that the maximum working pressure should be limited to 150 pounds per square inch or possibly 200 pounds. The steel bands should not be subjected to a greater stress than 15,000 pounds per square inch at the weakest section, nor the wood to an external pressure caused by the bands greater than 750 pounds per square inch, or preferably 500 pounds when the round rod has a bearing surface on the wood not to exceed the radius of the rod.

The wood used may be red wood, fir, white pine, Norway pine or cypress, thoroughly seasoned and air-dried before working into staves; free from loose or black knots or any knots that pass more than half way through the wood, from sap wood, wind shakes, check cracks, dry rot, pitch pockets or pitch seams. Pipes or staves should be stored in a dry place until they are ready to be laid.

For a machine spirally banded pipe, the gage

of the steel should not be less in thickness than No. 14 B. G. W. except for low pressures. For pipe with diameters of 8 inches and below, No. 18 gage may be permitted.

After the pipe has been laid, a test for leakage should be made under the working pressure and this should not exceed 700 gallons per 24 hours for each inch of diameter of pipe per mile.

Mr. Ledoux recommends that in calculating the carrying capacity of wood pipe the value of C in the Chesey formula be taken at 110, although the capacity may be greater in many cases.

CONDITIONS FAVORING WOOD PIPE

Summing up the conditions under which wood pipe may profitably be used, the author believes that the ideal condition for wood pipe is where it is to be subjected constantly to pressure from an elevated reservoir and never allowed to become empty except temporarily for repairs or emergency. It may not be seriously objectionable to have a pipe empty occasionally for even a week at a time if it is covered up in a trench; but where it is exposed in the open air it should be kept constantly full of water under material pressure.

Wood pipe should never be laid in cinder-fill ground or in places where mine water could reach the bands, for under these conditions the bands are almost sure to rust and break within a very short time. The same, however, would be equally applicable to steel pipe or cast iron pipe.

Mr. Ledoux states that probably more than 500 miles of wood pipe is installed each year and that more than 500 municipalities and water companies in the United States are making use of it. The sizes range from 4 inches to 60 inches and their pressures up to 150 pounds. Some of the companies sell quite a little creosoted pipe, and creosoting probably doubles the life of the wood, but in the majority of situations the life of the pipe is dependent upon that of the steel rods and bands rather than the wood.

In discussing some of the characteristics of wood pipe, the author states that one reason why a great deal of trouble is experienced with leakage in large wooden pipes is that, when the pipe is laid in a trench with considerable fill over it and the pressure is low, the pipe will assume an oblate form, the vertical diameter being materially less than the horizontal. If the pressure is increased materially, the pipe becomes more nearly circular in form and the joints between the staves become less tight with this change of form. The remedy is to constantly operate this class of pipe under fairly uniform pressures.

The author gives in his paper quite full formulas, tables and data for calculating the thickness of wood staves, diameters of round or dimensions of flat rods to be used, spacing between centers of rods, etc., for each size of pipe and for pressures varying from 25 pounds to 150 pounds. He also gives calculations for water hammer and discusses the carrying capacity of wood pipe.

Altogether the paper is perhaps the most complete discussion of the subject of wood pipe from the engineer's point of view that has yet appeared.

Operating Sewage Treatment Plants

We have from time to time called attention to the importance of faithfully and properly operating sewage treatment plants and have published one or two sets of instructions prepared by state health boards. The following "guide," prepared by Burns & McDonnell Engineering Company, is briefer than some others, but probably touches all the points that it is necessary to bring to the attention of municipal authorities, for whom it is intended. In fact, its brevity is undoubtedly an advantage for such purpose.

As the authors say: "No guide to the operation of treatment plants can cover all cases and at times unforeseen problems may arise due to a period of neglect or to local conditions which cannot be solved by the regular operator. At such times expert advice will be required and cities should confer with consulting engineers or the Sanitary engineer of the State Board of Health. The employment of engineers to advise concerning operation of plants and closer co-operation with State Boards of Health would go far toward transforming many well-designed plants from a state of neglect to one of efficient operation."

NATURE OF SEWAGE

Great variation in quantity and quality of sewage exists in different cities, due to entrance of seepage water, roof water, and industrial wastes into the sewers. For economical and efficient operation of a treatment plant it is desirable that a minimum of seepage and no roof water be allowed to enter. Fresh sewage is desired for Imhoff tank treatment. Some industrial wastes, such as tar and oil from gas plants and refineries and washings from garages are particularly troublesome; stringent regulations should be enforced by cities to prevent such wastes from reaching the sewers to keep their treatment plants operating efficiently.

BY-PASSES

No raw sewage should be by-passed except when absolutely necessary.

GRIT CHAMBERS

Screens should be cleaned at least once per day and more often if necessary.

Grit chambers should be cleaned out whenever the accumulation of grit becomes such that grit tends to wash through; removed contents should be buried, or dried on sludge bed.

SEPTIC TANKS

Inlet and outlet channels and weirs should be kept clean.

Sewage solids will accumulate as settled sludge or floating scum; contents of tank should be disturbed as little as possible. When combined depth of scum and sludge equals one-quarter of the tank depth, the solids should be removed, preferably in spring or fall, when sludge will dry quickly.

Removed material may be buried, or dried on sand

beds. No open flame lamps should be taken into any septic tank on account of the explosive character of accumulated gases.

IMHOFF TANKS

Channels.—All channels should be cleaned at frequent intervals and always before reversal of flow, using care that deposits are not washed into tanks.

Settling Chambers.—When putting Imhoff tanks into service for the first time, or after pumping out and cleaning, if sewage is concentrated and flow heavy, the tanks should be filled with the more dilute night flow or clear water and the amount of sewage admitted to the tanks gradually increased, in order to build up the bacterial action.

Non-settleable material, such as oil and grease, should be skimmed off daily, burying or burning it.

Settleable material behind baffles and scum on surface of setting chambers should be skimmed off daily, throwing it into gas vents.

All vertical walls and sloping bottoms of settling chambers should be cleaned with rubber squeegees slowly, forcing the deposit entirely through the slot, taking care that the deposit is not stirred up and carried into outlet.

When reversing channels are provided the flow through the tanks should be reversed every week or two, previously skimming off all floating materials behind inlet baffles and squeegeeing all wall surfaces between baffle and end wall at inlet and allowing time for settlement.

Gas Vents.—The scum in the gas vents should be broken up daily by sprinkling with water or agitating with a rake to release the entrained gases and any material which cannot be made to settle should be removed and buried or burned.

If foaming occurs and cannot be controlled, the City should advise with its consulting engineer or the sanitary engineer of the State Board of Health.

Sludge Chamber.—Sludge should not be allowed to accumulate nearer than eighteen inches to the slot at the bottom of the settling chamber. The surface of the sludge may be determined by means of a wood or sheet iron plate attached to a wire or light rod.

Sludge should be removed at intervals by opening valves slowly on sludge pipes, it being better to remove small amounts frequently than large amounts infrequently.

Sludge should be drawn off slowly to allow continuous settlement of sludge around base of sludge pipe; only well-digested sludge should be withdrawn, known by its brownish-black color, more or less granular and frothy appearance, and faint tarry or rubbery odor as opposed to the grayish color, sticky and pasty appearance and foul odor of partly digested sludge.

Late each fall the entire amount of digested sludge should be withdrawn to provide sufficient storage capacity for winter sludge.

Vertical and horizontal sludge pipes should be cleaned by rodding to break up old deposits before opening valves. The sludge pipe may be backfilled with water or settled sewage after drawing sludge.

At intervals of several years, dependent upon local conditions and kind of plant operation, the tanks may require to be pumped out and cleaned out thoroughly.

SLUDGE BEDS

Sludge should not be drawn upon the bed until all dried sludge has been removed therefrom; well-digested sludge only should be dried upon the bed and should be drawn to a depth preferably not over six to eight inches and never over twelve inches.

When thoroughly dried the sludge should be removed, being careful to remove as little filter sand as possible, and may be used for filling in low places without nuisance, or for lightening and furnishing humus to heavy soils.

Thin layers of sand should be applied to the bed from time to time to compensate for losses during removal of sludge.

DOSING CHAMBER

Before starting, the siphon should be filled with water and all pipe connections to the siphon should be kept continuously airtight.

The sides and bottom of the dosing chamber should be cleaned down occasionally, and all floating material should be skimmed off frequently.

SPRINKLING FILTERS

Sprinkling nozzles should be examined daily and kept clean.

The surface of the stone should be kept free from leaves, papers, and vegetable growth.

In case organic growth in the bed and moth-flies with their larvae become troublesome, chemicals such as caustic soda, copper sulphate or hypochlorite of lime may be used in proper quantities for their control.

FINAL SETTLING TANK

The sludge should be removed frequently so that it will not become septic.

CONTACT FILTERS

The apparatus for filling and emptying the beds should be examined frequently and kept in perfect operation.

The surface of the stone should be kept free from foreign material and vegetable growth.

When the stone becomes clogged with sewage solids, at intervals of five years, more or less, the entire bed of stone will require to be removed, washed, screened and replaced.

SAND FILTERS

Sand beds should be dosed alternately to allow cleaning, resting and drying. The distributors should be regulated to secure even distribution of sewage.

Before dosing, any accumulated sludge should be removed and the bed raked lightly to a depth of one-half inch to break the surface.

When the bed becomes clogged so that sewage will not percolate, the surface sand should be scraped off to a depth of one inch and raked. At longer intervals new sand of suitable quality must be added to the bed.

Teams and heavy loads should not be driven over the bed. Holes should not be dug into the sand to pass sewage directly to drains and any wash-ins should be repaired at once. No growth of vegetation should be allowed on the bed.

In the northern states the sand should be piled or ridged in late fall for winter operation to prevent ice from freezing to the sand, and every opportunity utilized for cleaning the bed.

Recent Legal Decisions

TEMPORARY INJUNCTION REFUSED AGAINST MUNICIPAL CONTRACT ALLEGED TO BE IN VIOLATION OF CHARTER

In an action to restrain a municipal corporation from entering into a contract with a public utility company for the supply of electric energy for the village, alleged to be in violation of the competitive provisions of the village charter, and to work an abandonment of an existing municipal lighting plant, without a vote of the taxpayers as required by the Minnesota statute, the Minnesota Supreme Court holds, Wagner v. Cramer, 188 N. W. 65, that the trial court did not abuse its discretion in denying a motion for a temporary injunction restraining proceedings pending the action. The village plant had become a burden, owing to the high price of coal and labor, and was being operated at a loss, and the council's object was to pave the way, should the temporary experiment result economically to the village, for abandonment of the village plant.

STATE NOT LIABLE FOR DELAYS PRIOR TO ITS EXECUTION OF HIGHWAY CONTRACT

Section 130 of the New York Highway Law provides that the execution of a formal written contract after its approval by the Comptroller is essential to establish liability of the state for any delays prior to its execution, however inequitable the state's conduct may have been. A contractor who had been awarded a contract for the improvement of a state highway executed the contract on his part and filed the required bond. His papers appeared satisfactory to the commissioner of highways, who, however, so delayed execution of the contract on the part of the state that it was impossible to complete the work before winter, and, by mutual consent, its commencement was postponed until the following spring. The work was then begun and completed, but, because of the increased cost of labor and materials, the expense was greater than if it had been done during the preceding fall. The New York Court of Appeals held, Belmar Contracting Co. v. State, 233 N. Y. 189, 135 N. E. 240, that the contractor could not recover his damage from the state. The unexcused failure of the comptroller to approve of the contract was held a personal fault for which the state was not liable. The only remedy the contractor would have had for nonexecution of the contract within a reasonable time was to withdraw its bid and recover its deposit.

CONDEMNATION OF LAND FOR PUBLIC PARKS

The Ohio Supreme Court holds, Nichols v. City of Cleveland, 135 N. E. 291, that where one entire plan has been adopted for a public improvement, and from the inception a certain tract of land has been actually included therein, the owner of such tract in a condemnation proceeding therefor is not entitled to an increased value which may result from the improvement, where its appropriation is a condition precedent to the existence of the improvement. It is also held that the public and abutting owners do not have such vested rights in the walks and driveways which are laid out and improved as part of a public park as will preclude the park authorities from relocating the same whenever and in such manner as they may deem best suited to the purposes of the park.

CHANGE IN ROUTE OF PIPE LINE HELD NOT TO RELIEVE CONTRACTOR'S SURETY

A change in the route of a pipe line due to difficulty in obtaining rights of way involving an increase in length of about 877 feet, the total length of the line being 3,800 feet, is held to come within the language of a construction contract authorizing chances deemed necessary in the opinion of the engineer for the betterment of the work, and is not such a change as will relieve a surety company guaranteeing the faithful performance of the contract.—Village of Newark v. James F. Leary Const. Co., 194 N. Y. Supp. 212.

TEXAS MUNICIPALITY SUPPLYING WATER CANNOT REFUSE TO SUPPLY TENANT OF PART OF A BUILDING OR MAKE OWNER ASSUME TENANT'S LIABILITY

As a general rule, the obligations to the consumer of a municipality operating a water supply are the same as those of a private corporation engaged in such business. It is the duty of the organization supplying the water to supply it impartially to all reasonably within the reach of its pipes and mains. This service must be given without discrimination between the persons similarly situated or under circumstances substantially the same. Water must be furnished to all who apply therefor, offer to pay the rates, and abide by such reasonable rules and regulations as may be made a condition of rendering service. The company or the city cannot escape from its duty to furnish an applicant on demand, merely because he is already in receipt of a supply indirectly through the medium of another. The owner or occupant of a building has the right to deal directly with the city for his supply of water. Applying these principles, the Texas Supreme Court holds, City of Galveston v. Kenner, 240 S. W. 894, that an ordinance of a city operating its own water supply system having the effect of denying to a tenant the right to water unless he is in possession of the entire building, and denying the right to erect buildings for rental unless the owner assumes the obligation of paying the tenants' water rents, is unreasonable and void.

SALE OF STREET IMPROVEMENT BONDS ON CREDIT HELD INVALID

The Tennessee Supreme Court holds, Reed v. Mayor and Aldermen of City of Athens, 240 S. W. 439, that the sale of street improvement bonds, permitting the purchaser to retain the proceeds without security to the city, and to pay the city only as the work progressed, was invalid, the arrangement amounting to an extension of personal credit by the city to the purchaser, for the full consideration to be paid by him, if he should decide not to pay any part of the consideration in cash. Such an arrangement, if permitted, might, the court said, result in heavy financial loss to the city.

NEWS OF THE SOCIETIES

CALENDAR

Aug. 8-10—UNION OF CANADIAN MUNICIPALITIES. Annual convention, Winnipeg, Man. Secretary, A. D. Shibley, 10 St. John St., Montreal.

Aug. 15-17—LEAGUE OF IOWA MUNICIPALITIES. Annual meeting. Secretary, F. G. Pierce, Marshalltown, Ia.

Aug. 15-18—INTERNATIONAL ASSOCIATION OF FIRE ENGINEERS. Fiftieth convention. Municipal Auditorium, San Francisco, Cal. Secretary, James J. Mulcahey, Chief, Yonkers, N. Y., Fire Dept.

Aug. 19-26—AMERICAN INSTITUTE OF PARK EXECUTIVES. Annual convention, Minneapolis, Minn. Secretary, Emmett Griffin, Supt. of Parks, East St. Louis, Ill.

Aug. 22-25—INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS. Annual convention, New Bedford, Mass. Secretary, Clarence R. George, City Electrician, Houston, Tex.

Aug. 28-Sept. 2—NATIONAL SAFETY CONGRESS. Detroit, Mich.

Aug. 29-30-31—LEAGUE OF CITIES OF THE THIRD CLASS IN PENNSYLVANIA. Annual convention, Williamsport, Pa. Fred H. Gates, Secretary, Wilkes-Barre, Pa.

Sept. 11-15—ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS. New Auditorium, Cleveland, Ohio.

Sept. 12-13—NEW ENGLAND WATER WORKS ASSOCIATION. 41st annual convention. New Bedford, Mass. Secretary, Frank J. Gifford, Tremont Temple, Boston, Mass.

Sept. 14-16—AMERICAN ASSOCIATION OF PORT AUTHORITIES. Convention at Toronto. Secretary, M. P. Fennell, Jr., Montreal.

Sept. 19-23—LEAGUE OF CALIFORNIA MUNICIPALITIES. Annual convention, Palo Alto, Cal. Executive secretary, W. J. Locke, Pacific Bldg., San Francisco.

Sept. 25-28—SOUTHWEST WATER WORKS ASSOCIATION. Annual convention, Hot Springs, Ark. Secretary, E. L. Fulkerson, Waco, Tex.

Oct. 1-6—AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS. Annual convention, Cleveland, Ohio. Secretary, Charles C. Brown, St. Petersburg, Fla.

Oct. 16-19 — AMERICAN PUBLIC HEALTH ASSOCIATION. Annual meeting, Chicago, Ill. Secretary, A. W. Hedrick, 370 Seventh Ave., New York, N. Y.

Nov. 15-16—NATIONAL INDUSTRIAL LEAGUE. Annual meeting, New York City. Secretary, J. H. Beck, Chicago.

Dec. 7-13—NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING. New York City.

AMERICAN ASSOCIATION OF ENGINEERS' NOTES

The Board of Directors of the American Association of Engineers has voted to accept the invitation to become a member of the American Construction Council.

The Richmond Chapter on July 5th gave a dinner to H. G. Shirley in honor of his appointment as chairman of the Virginia State Highway Commission, at which were present as guests Governor Trinkle, Mayor Ainslie of Richmond, Attorney-General Saunders and officers of the leading civic and professional clubs of the city.

The Seattle Chapter recently sponsored a public meeting at which Fred A. Adams, supervisor and educational director of the Columbia Basin project, and Ivan E. Goodner, chief engineer, explained the huge irrigation plans.

ENGINEERS' SOCIETY OF MILWAUKEE

This society has elected the following officers for the coming year: President, Arthur Simon, engineer of the Cutler-Hammer Manufacturing Co.; vice-president, Fred H. Dorner, mechanical engineer; treasurer, A. Q. Dufour, mechanical engineer, and secretary, Fred T. Goes, engineer of the Vilter Manufacturing Co.

Following the election of officers Mr. Dorner was presented with a gold watch in appreciation of his services as secretary of the society for the past ten years.

AMERICAN ASSOCIATION OF PORT AUTHORITIES

The eleventh annual convention of the American Association of Port Authorities is to be held in Toronto, Ont., Sept. 14 to 16, 1922. The convention will be followed by an excursion down the St. Lawrence river to Montreal and then to Quebec, at both of which cities the port facilities will be inspected under the auspices of the local authorities. The secretary of the association is M. P. Fennell, Jr., of the Port of Montreal.

SOUTH APPALACHIAN WATER POWER CONFERENCE

Hydraulic engineers in the south have organized an association to be known by the above name, electing as president Col. Joseph Hyde Pratt, director of the North Carolina Geological and Economic Survey; Lincoln Green, first vice-president of the Southern R. R. as vice-president; Prof. J. A. Switser, of Tennessee, as secretary; and Thorndike Saville, chief of the Division of Water Resources of the North Carolina Geological and Economic Survey, as treasurer.

The Federal government was represented by N. C. Grover, chief hydraulic engineer of the U. S. Geological Survey; O. C. Merrill, executive secretary of the Federal Power Commission; C. H. Birdseye, chief topographer of the U. S. Geological Survey; C. V. Hodgson, of the U. S. Coast and Geodetic Survey; T. W. Norcross, chief engineer of the U. S. Forest Service; Col. H. B. Ferguson, assistant secretary of war; and Warren E. Hall, district engineer, U. S. Geological Survey.

Most of the leading hydraulic engineers of the south were present. Papers were presented discussing water power development in the southern states, and several committees were appointed. One of these committees, on Energy Supply, will study location of undeveloped water powers in the southern Appalachian states, the order of development, the location of auxiliary steam plants, making of water-power surveys, taking of stream-flow measurements, the problem of silting, etc. Another will treat of inter-connection of the various power developments, and a third will consider proper Federal and state legislation to aid in water-power development.

PERSONALS

Phillips, Harry W., has been appointed superintendent of construction for the city of Davenport, Iowa.

Taylor, Thomas, for the past 10 years designing and constructing engineer for the Department of Works of Toronto, Ontario, has been promoted to the position of engineer of railways and bridges of that department.

Strouse, William F., has resigned as chief engineer of the Public Service Commission of Maryland and will be succeeded by H. Carl Wolf, now engineer of public utilities for the commission. Mr. Strouse, as valuation engineer, will continue to be a member of the commission's engineering staff.

Blauvelt, Major L. D., has resigned as state highway engineer of Colorado, to become chief construction engineer for the Moffat Tunnel Commission, Denver, Colorado, which will construct a 6-mile railroad tunnel through the Continental Divide.

Godward, A. C., engineer for the Minneapolis Board of Park Commissioners, has been appointed engineer for the recently created Minneapolis City Planning Commission.

Ford, Frederick L., city engineer of New Haven, Conn., has been appointed by Governor Lake one of six members of a commission from that state which, with similar commissions from the other New England states, will work out a plan for consolidating New England's railroads into one compact system.

Perron, J. L., has been appointed minister of roads for the Province of Quebec, Joseph Boulanger will replace B. Michaud as deputy minister and G. Henry, formerly chief engineer of the department will act as consulting engineer.

Russell, Captain A. L., civil engineer and Dominion land surveyor, formerly of Port Arthur, Ontario, Canada, died June 11 in Ottawa, aged 80 years.

Waud, Joseph B., for many years surveyor and engineer for Ventura County, California, died June 1.

de Ruiz, Captain Albert, for 12 years city engineer of Long Beach, California, died at his home in that city on May 29, aged 69 years.

New Appliances

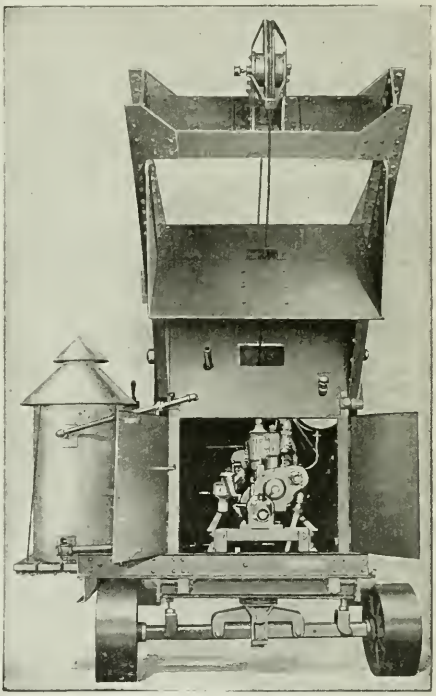
Describing New Machinery, Apparatus, Materials and Methods and Recent Interesting Installations

SMITH EXCAVATOR AND LOADER

The Wisconsin four-cylinder gasoline engine used on Smith Pavers has also been adopted for excavators and loaders, made by the T. L. Smith Company. The new motor has 3-inch bore and 5-inch stroke and runs at 1,200 R. P. M. It provides about 40 per cent. additional power over the previous equipment. A recent installation of this new-motored machine is shown in the accompanying illustration, where the excavator and loader is shown excavating and loading gravel from a gravel pit. The loaded scraper is brought to the excavator and dumped directly into the waiting truck.

These machines are used for general drag-line excavating, for digging basements and loading dierctly into wagons or trucks on the surface; for grading, stripping and miscellaneous earth handling and loading.

SMITH EXCAVATOR AND LOADER ON GRAVEL PIT WORK



END VIEW OF SMITH EXCAVATOR AND LOADER, SHOWING NEW MOTOR

THE LAMOTTE HYDROGEN-ION COMPARATOR SET

This is a portable outfit for the Colorimetric study of the Hydrogen-Ion concentration of liquids and solutions, made by the LaMotte Chemical Products Company.

The set embodies all the conveniences possible in a portable outfit, and enables direct determinations of H-ion concentrations to be made either in the field, at the station, or in the boiler house, without additional equipment. The whole outfit may be carried at ease as all reagents and equipment are contained in a polished wooden case approximately 5 inches long, 6 inches high and 2 inches thick. The case serves as a combined comparator block and tube rack, and permits the viewing of three double rows of tubes simultaneously. Within the case are ten standard color tubes of 15mm. diameter, two extra graduated test tubes of the same bore and thickness, 20cc. standardized indicator solution and one 0.5cc. graduated pipette for measuring indicator. Color tubes and corresponding indicator solution can be supplied covering any portion of the range pH. 1.0 to 10.0 in consecutive integers of 0.2 pH. Phenol Red tubes are usually supplied since they cover the range encountered in ordinary work, but other standards may be obtained upon specification.

PARKER-LAWYER CO.

Frederick J. Parker, formerly secretary of the Arthur McMullen Company, announces the severance of that connection and the formation of the general contracting organiaztions of the Parker-Sawyer Company, railroad and general construction, and of the Engineering Construction Corporation, highway contractors, with offices at 720 Commercial Trust Building, Philadelphia.

INDUSTRIAL NOTES

National Tube Company has opened new offices in the Empire Building, 71 Broadway, New York City, with Clifton Wharton, Jr. as manager.

The Fulton Company, manufacturers of heating specialties, Knoxville, Tenn., has recently been organized. The new officers are: W. M. Fulton, President and Treasurer; Warren Webster, Vice-President; C. N. Mynderse, Executive Manager; Henry Hudson, Secretary.

CONTINUOUS EXCAVATION AND REMOVAL OF DIRT.

A bulletin issued by the Holt Mfg. Co., Inc., illustrates the use of Holt Caterpillar tractors of 5 and 10 tons capacity each for hauling trains of dump wagons and excavating grader machine respectively at speeds varying from 1.5 to 5.7 miles per hour for forward and reverse on very heavy to light work and in moving from place to place. The 10-ton caterpillar can easily handle the largest grading machine or haul two 5-yard dump wagons replacing 12 teams and 12 skinners. The caterpillars are adapted to frequent stopping and starting and can turn in very short radius. Their use enables the work to take place continuously at a speed that insures a very large amount of excavation in a short time.

Peterson, Shirley & Gunther, contractors, Omaha, have installed 18 Holt caterpillar tractors on their work.

PUBLIC WORKS. 97

CITY COUNTY STATE

A Combination of "MUNICIPAL JOURNAL" and "CONTRACTING"

Vol. 53 August, 1922 No. 6

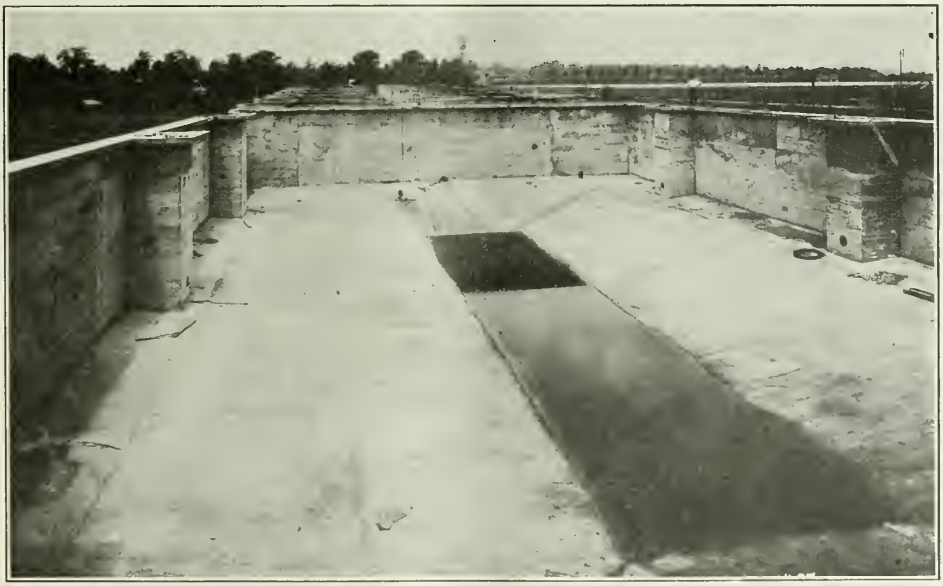
Sludge Digestion Tanks at the Baltimore Sewage Works

By C. E. Keefer*

Sedimentation and sludge digestion tanks cheaper to construct and to operate than Imhoff tanks, less troublesome, and give equally as good results. Sludge digestion is being used in future development of Baltimore plant. History of this feature of the Baltimore works.

The sewage treatment plant of Baltimore is receiving the sewage from approximately 550,000 people. This sewage is domestic in character and amounts to nearly 50 m. g. d. In order to prevent it from creating a nuisance, treatment units costing approximately $3,000,000 have been constructed. As the population of the city, according to the 1920 census, was 733,826, and as sewers are being extended at the rate of almost two miles a week, there is no doubt but that the sewage flow will increase materially for the next few years. To provide for this additional flow, more treatment units will have to be constructed.

* Assistant Designing Engineer, Sewer Division, Baltimore, Md.



INTERIOR VIEW OF SLUDGE DIGESTION TANK NO. 20, BUILT 1921
Tops of old circular sludge digestion tanks seen immediately beyond. Sludge beds seen faintly at the left

GENERAL DESCRIPTION OF PLANT

The sewage works are situated on a tract of land containing 468 acres, which was purchased in 1906. The various types of tanks, filters, and sludge drying beds cover approximately 45 acres of ground, and plans are being prepared to materially increase the size of the plant. The sewage, which averaged, in 1921, 252 p.p.m. of suspended solids, first flows through a bar screen house where large floating matter is caught and removed. From the screen house it passes through four Venturi meters to sedimentation tanks, of which there are four at present. From the sedimentation tanks the sewage flows through revolving screens to 30 acres of trickling filters. After leaving the trickling filters it continues to two final settling basins, from which it passes through water turbines to Back river.

SLUDGE DIGESTION TANKS

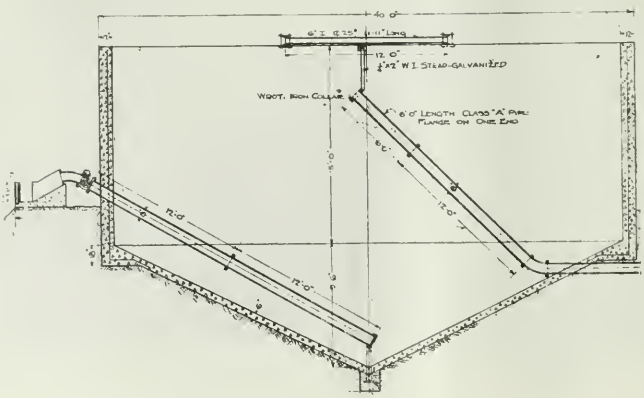
The sludge from the sedimentation tanks is pumped to sludge digestion tanks, where it remains for a period of from three to six months. At the end of this time the amount of organic matter in the sludge has decreased by gasification and liquefaction, and is sufficiently stable so that it can be dried on sludge beds in a comparatively short period of time. There are 7.6 acres of these beds where practically all of the sludge from the plant is dried. Some of this air-dried sludge is carted away by farmers, but the larger portion of it is heat-dried and sold as a base for fertilizers.

SEDIMENTATION TANKS VERSUS IMHOFF TANKS

Baltimore has been very fortunate in being able to make a study of the use of Imhoff tanks and plain sedimentation tanks used in conjunction with sludge digestion tanks. Unfortunately, the experience with the 28 circular Imhoff tanks has not been what was anticipated when these tanks were built. The Imhoff tanks have been in operation continually for several months at a time, and even when they were giving satisfactory service, it is safe to say that the use of the four sedimentation tanks, together with the sludge digestion tanks, was preferable.

In reaching the solution of a problem of this sort, the economics of the question is often a deciding feature, and it has been found that at Baltimore it has cost considerably more to treat the sewage when Imhoff tanks were used as compared to treating the same sewage through plain sedimentation tanks and sludge tanks. The reason for this is easy to explain. First of all, Imhoff tanks of any depth are much harder to construct. The excavation must be carried to greater depths. Heavy concrete construction is necessary. With the building of plain sedimentation tanks these conditions do not exist as a general thing. When it comes to the operating of Imhoff tanks, a good deal of supervision is necessary in order to keep them running in a satisfactory manner, and it is undoubtedly true that there are several installations where Imhoff tanks are not giving satisfaction even where the greatest degree of supervision is exercised. Gassing and foaming are likely to occur at any time due to causes which very often are unknown; at least, such has been the case at Baltimore.

Not long after the Imhoff tanks at Baltimore were put in service they began to give trouble due to foaming. They had been in operation approximately a year when it was necessary to shut them down. It was apparent to those familiar with the conditions that the troubles encountered were chiefly due to two causes: first, the sludge storage space in the tank was inadequate, and, second, the hydraulics was poor. In May, 1919, two of the twenty-eight tanks were remodeled. The inlet and outlet weirs of these tanks were raised, and the flow of sewage was slightly modified so that in entering the tank it flowed over the top of the weirs instead of passing downward through openings in the bottom of the inlet channel. These two tanks worked very satisfactorily for a period of over a year. It was then decided to remodel the other twenty-six tanks in the same way that the two tanks mentioned above had been changed. As each tank was changed it was put in service, so that by January, 1921, eighteen tanks were in use. For some unknown reason, first one and then another of them started to gas and foam, so that in the course of a few weeks it was necessary to shut down the whole battery, and up to the present time they have not been used as sedimentation tanks at all. Instead of having these tanks stand idle, they are now being used temporarily as sludge digestion tanks, and are giving very satisfactory service.



CROSS-SECTION OF OLD TYPE OF SLUDGE DIGESTION TANK

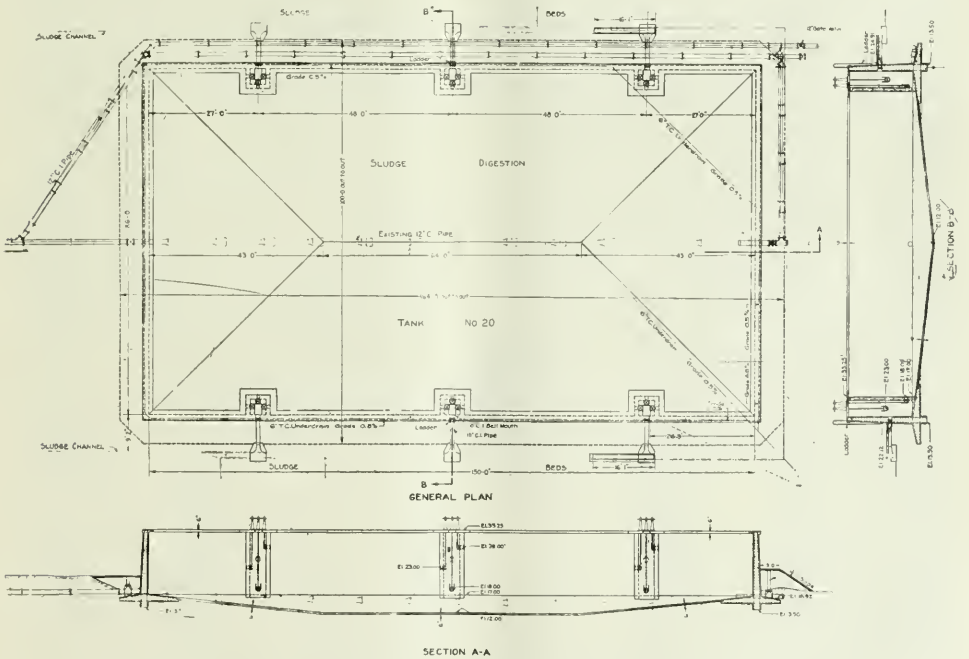
OPERATION OF SEDIMENTATION TANKS

There are four sedimentation tanks, each having a capa-

city of 3,800,000 gallons. They are alike with the exception of a few minor details. Each of these tanks is 420 feet long, 103 feet wide, with a depth varying from 10½ to 15½ feet. In the summer months they are kept in operation for a period of about ten days before they are cleaned, whereas in winter they are operated continuously from three to six weeks. As soon as a tank is put out of service, the supernatant is pumped to one of the other tanks in operation, and then the sludge is pumped into one of the sludge digestion tanks. The length of time required to move this material varies considerably with the quantity in the tanks and the amount of moisture it contains. If these tanks have been in operation only about ten days, the total time required to clean them does not take longer than four or five days. On the other hand, if they are run for a month or six weeks this amount of time is greatly increased. The tanks are cleaned by flushing the sludge with streams of water to channels, from which it flows by gravity to centrifugal pumps. These pumps are used to lift the sludge to the sludge digestion tanks.

DESIGN OF SLUDGE TANKS

The first three sludge tanks, Nos. 1 to 3, built at Baltimore were rectangular in shape, 140 feet long, 103 feet wide and from 13½ to 15½ feet in depth. Sludge is fed into these tanks through a cast iron pipe line which is attached along the top of the walls opposite the outlets of the tanks. In order to prevent odors from escaping when raw sludge is fed into the tanks, short removable pieces of pipe, which extend below the surface of the sludge in the digestion tanks are attached to the main sludge pipe. Each tank was provided with three manholes, at the bottom of which are 12-inch sluice gates, one for each manhole. The manholes are connected by a conduit to a small pumping station, which is equipped with a 10-inch centrifugal pump. When these tanks were designed, it was anticipated that as the sludge was fed into them it would gradually digest and settle to the bottom of the tanks, leaving a layer of water at the top. On the top of the walls of these tanks a small rectangular conduit was constructed for removing this water. This conduit, however, has not been used for several years, as the water never collects on the surface of the sludge. The reverse condition of what was anticipated has taken place. As the sludge remains in the tanks, gas action naturally begins, and material is forced to the surface, which in the course of time becomes dry and hard. There have been times when this scum has been sufficiently hard and thick to support the weight of workmen. In order to get the sludge to the pump it is necessary to break it up with a stream of water so that it will flow through the conduits. The capacity of the above tanks amounts to 608,700 cubic feet. It very often happens that undigested sludge flows directly underneath the scum to the outlets. About a year ago additional out-



PLAN AND VERTICAL SECTIONS OF NEW SLUDGE DIGESTION TANK

let points were built at higher elevations in the manholes, and should undigested sludge be found at one elevation, the chances of getting digested sludge from one of the other points are increased.

In 1915, when more sludge digestion space was needed, sixteen more tanks, Nos. 4 to 19, were built of an entirely different design. All of these tanks are of the same size and shape. They are 38 feet in diameter and 24½ feet deep. The bottoms are hopper shaped, the depth of the hopper being 9½ feet. It was thought that these tanks would behave in the same way as the rectangular tanks were supposed to act, namely, that the digested sludge would form at the bottom, while the undigested material would remain at the top. One inlet pipe and one outlet pipe was provided for each tank. The inlet pipes are 8 inches in diameter, terminating near the top of the tank. The outlet pipes are at the bottom. Unfortunately, the digested sludge accumulates at the top of the tank, with the undigested material at the bottom. These tanks evidently cannot be operated as easily as might be the case if these pipes had been placed in the reverse positions.

Sludge Tank No. 20, which was the last one built, was completed in September, 1921. When this tank was designed, several features not a part of the old tanks were added. This tank is 150 feet long, 86 feet wide, with a depth varying from 16 feet 3 inches to 21 feet 3 inches. Sludge is fed into the tank at opposite ends through a 12-inch cast iron pipe placed at the bottom of the tank. Sludge can be withdrawn from one of six manholes, three of which are on one side, with the other three along the opposite side. Each manhole is provided with three 10-inch circular sluice gates placed at different elevations. In operating these sludge tanks it has been learned through past experience that it is not wise to have all of the draw-off points at the same elevation, because it is possible for digested sludge to be at different elevations in the tank. The capacity of this tank is 233,000 cubic feet. It is built entirely of reinforced concrete at a cost of $58,881.04. Parallel with and a few feet away from the north and south sides of the tank there are two concrete channels, each 1 foot wide and 1 foot 6 inches high. The digested sludge is drawn from the tank into these channels, and from there to the sludge drying beds. As it is difficult to get sludge to flow in very long open channels, it is planned to use cast iron pipe lines in the future for carrying the digested sludge to the drying beds.

Table I gives the cost and capacities of the sludge tanks at the Baltimore plant.

TABLE I

Cost of Sludge Digestion Tanks at the Baltimore Sewage Works

Sludge Digestion Tanks Nos.	Year Built	Cost	Capacity, Cu. Ft.	Cost per Cu. Ft.
1-3	1909-1910	$43,311.00	608,700	7.1c
4-19	1914-1915	27,240.80	329,700	8.3c
20	1920-1921	58,881.04	233,000	25.2c*

* Increased cost due to high prices after the war.

SLUDGE PIPE LINES

As in the design of Imhoff tanks, it is as essential, if not more so, to have pipe lines of sufficient size through which the sludge can be pumped or made to flow from one tank to another. All of the pipe lines used for carrying sludge at the Baltimore plant vary from 8 to 12 inches in diameter. The main feeders are all 12 inches in diameter. A few of the distributing pipes to the tanks are 8 inches in diameter. The present practice is to use 12-inch pipes for main distributors, with 10-inch pipes for short branch lines. By using pipes instead of channels the amount and intensity of odors that would be created is greatly reduced.

OPERATION OF SLUDGE TANKS

Table II indicates the quantities of sludge handled yearly. The character of the sludge as it is pumped from the sedimentation tanks to the sludge tanks naturally varies. However, it is usually in an undigested state, containing in the neighborhood of 65 or 70 per cent volatile matter. The amount of time required to fully digest the sludge so that it can be placed on the sludge drying beds ranges from three to six months. This sludge resembles Imhoff sludge. It has the same general characteristics and dries as well.

Two or three entirely distinct and pronounced conditions have been encountered in operating the sludge digestion tanks. During the first few

TABLE II

Quantities of Undigested and Digested Sludge Produced at the Baltimore Sewage Works

	Flow of sewage		Cubic yards of 90 per cent. moisture undigested sludge produced		Cubic yards of 90 per cent. moisture digested sludge produced		Reduction in volume of sludge per cent.
Year	M. G. D.	M. G. per year	per M. G.	per year	per M. G.	per year	
1912	11.90	4,320.85	...	.....	1.52	6,568	...
1913	18.05	6,597.48	...	.....	1.72	11,348	...
1914	22.93	8,372.09	...	.....	3.85	32,233	...
1915	31.80	11,607.41	5.70	66,165	4.05	47,010	29.8
1916	39.16	14,374.00	5.53	79,488	3.69	53,040	33.3
1917	44.35	16,199.83	7.34	118,997	3.15	51,029	57.1
1918	52.82	19,284.78	6.06	116,866	3.32	64,025	45.2
1919	55.04	20,096.08	5.14	103,294	2.98	59,886	42.0
1920	52.17*	19,074.23	6.37	121,503	3.00	57,233	52.9
1921	46.62*	17,015.72	8.47	146,403	3.02	51,420	64.9

* The decrease in flow from 1919 to 1921 was due to the decreased use of water, although the number of buildings connected to the sewerage system increased.

years that the plant was run only a very thin scum formed on the top of the sludge tanks; and as there was plenty of sludge storage space, no difficulties were encountered. But as the quantity of sludge began to increase with the increasing flow of sewage, the scum on the tops of the tanks began to get thicker, with a moisture content less than 70 per cent at times. To get this sludge to flow through the pipe line, large quantities of water had to be added. The top layers of sludge not only contained less moisture but they also were more thoroughly digested.

This condition continued until September, 1921, when some very stale sewage was placed in one of these tanks and immediately violent gas action began, so that in the course of a few weeks it seemed as though the contents of the tank had been completely churned up. Instead of a heavy scum on the surface, the top layer contained a great deal more moisture than formerly, and gas action was noticed practically over the whole surface of the tanks. This sludge could not only be run through the pipe lines more easily, but it also digested much quicker and dried on the sludge beds more readily. As soon as one tank reached this condition, sludge from it was pumped to the other two rectangular tanks, and before cold weather all three of the rectangular tanks were gassing violently and were giving more satisfactory results. Unfortunately, cold weather prevented this condition from continuing, and the present lack of digested sludge for seeding purposes has at least partly prevented this condition from starting up again in the spring and continuing. As soon as additional sludge tanks are completed, every effort will be made to have this condition continue at least during the major portion of the year.

ODORS

Sanitary engineers are beginning to realize more and more that not only should a sewage treatment plant give a satisfactory effluent, but also that the odors produced should be reduced to a minimum, and many ways have been devised for curtailing these nuisances. Undoubtedly the sponsors of the activated sludge process have a strong argument for such a means of sewage treatment when they can show that in disposing of the sewage the odors produced are practically negligible. It has been thought by some that the storing of sludge in large open tanks would create considerable odors. Such has not been the case at the Baltimore plant. The sludge on the top of the tanks forms into a thick heavy mat, and it is safe to say that the odors coming from these tanks is less than from Imhoff tanks. Care must be exercised, however, in operating such a plant to see that the undigested sludge is not exposed to the air when it is being pumped from one point to another.

The belief is held by some that the chief difficulty with the use of separate sludge digestion is that it is difficult to remove quickly the sludge from the settling tanks to the sludge tanks. The results obtained at Baltimore indicate that it makes little difference if the sludge in the settling tanks is removed within a few hours or a month after it has settled out. It is true that after a tank has been in service for a long period of time its settling efficiency decreases. However, at Baltimore it has been possible to maintain a 65 per cent removal of settling solids even when the tanks are cleaned only once in six weeks.

PLANS FOR THE FUTURE

At the present time designs are being prepared for three sludge tanks having a capacity of 610,000 cubic feet. In all probability, many new features not tried out before either at Baltimore or at any of the other sewage treatment plants where sludge digestion is used, will be introduced. In the light of present day knowledge with reference to sewage treatment, it is likely that the future extensions to the plant will be of the same general character as those that have been built in the past. Although Imhoff tanks have given satisfaction at many places, the use of sedimentation tanks in conjunction with sludge digestion tanks has given good results at the Baltimore plant and is to be preferred to Imhoff tanks. It costs less to construct and operate a plant of the former design, and the settled sewage and sludge obtained are as good. In view of the fact that two of the largest sewage treatment plants in the world, namely, the one at Birmingham, England, and the other at Baltimore, have given such good results, there is much to be said for the use of plain sedimentation tanks in conjunction with sludge digestion tanks.

H. G. Perring is chief engineer of the Department of Public Improvements. The sewage treatment works are under the supervision of A. E. Christhilf, highways engineer, with M. J. Ruark, division engineer of sewers. The writer has charge of the design and construction of additions and extensions to the plant, and J. W. Holden is the superintendent.

War Material for Road Work

Surplus war material valued at $139,773,996 was delivered to the states for use in Federal Aid road construction up to July 1. Except five of the smaller states, every state has received supplies of this kind to an amount exceeding $1,000,000. Motor vehicles have been distributed totaling 29,325, in addition to a large number of tractors, trailers, etc.

There is still a large quantity of material in this country for distribution which will be further increased by material used by the Army of Occupation in Germany, which is soon to be brought back.

Cost of Grading Roads

The Bureau of Public Roads recently reported that road grading costs have reached a stable basis. In 1917 the average cost for grading on Federal Aid roads was 38 cts. a cubic yard, but in 1920 it reached 66 cts. During the three months ending August 1, 1922, the average price per cubic yard for the whole United States was 33 cts.

St. Louis Water Works Operation

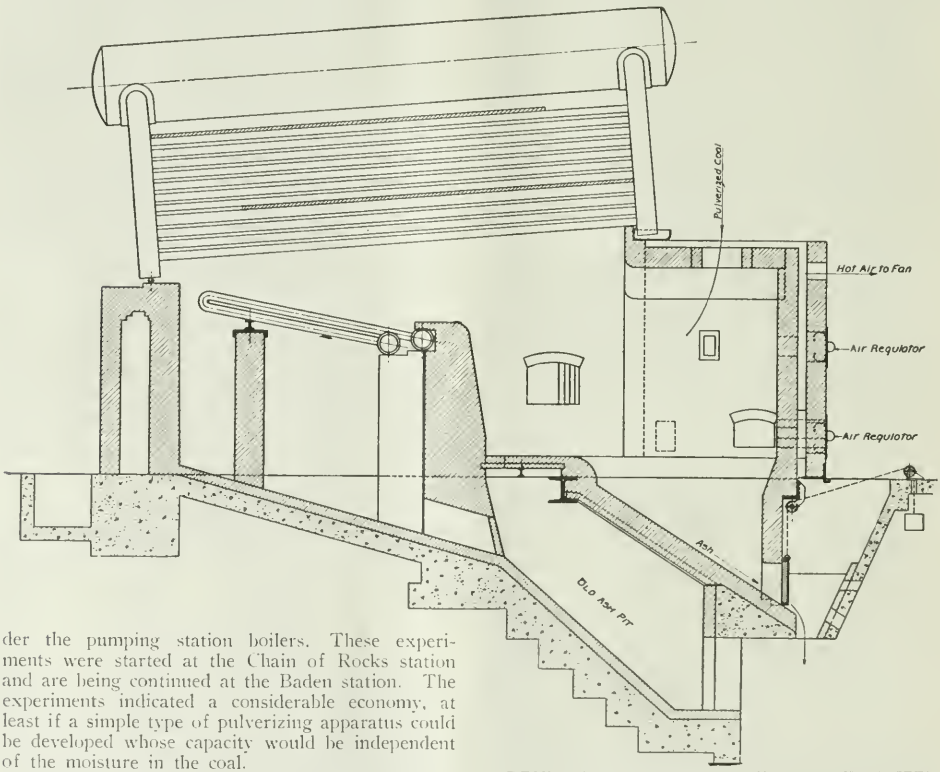
Improvements in use of fuel, effected and contemplated. Some features of proposed pumping and purification plant. Cement gun for removing coating from filter sand. Disc harrow for cleaning mixing conduits. Cleaning 195 miles of mains. Some features of metering. Average and maximum consumption rates

The St. Louis water works, one of the largest and most efficiently operated in the country, developed little that was out of the ordinary in its operation during the fiscal year of 1921-22, but in several respects increased the efficiency of its operation and conducted a number of experiments and tests with a view to introducing improved methods in the future. Also, plans were perfected for the new water works which are to be located on the Missouri river about 8 miles above St. Charles.

USE OF PULVERIZED COAL

One of the interesting experiments conducted as a basis for future improvement in operation was made with a view to learning the desirability and best method of using pulverized coal as a fuel under the pumping station boilers. These experiments were started at the Chain of Rocks station and are being continued at the Baden station. The experiments indicated a considerable economy, at least if a simple type of pulverizing apparatus could be developed whose capacity would be independent of the moisture in the coal.

It was found that the pulverized coal ignited immediately upon entering the furnace and combustion showed a possible carbon dioxide content of the flue gases of from 14 per cent. to 15 per cent., a high ratio when compared with the theoretical maximum of 17.9 per cent. for the coal used. An analysis of the unconsumed carbon in the ashes showed less than 6 per cent. combustible in the ashes, representing a loss of less than 1 per cent. of the total heat value of the coal. Present average operating conditions show a carbon dioxide content of the flue gases of about 10 per cent. and an unconsumed combustible in the ash of about 15 per cent., representing about 3½ per cent. of the total heat value of the coal. These two, the flue gas loss due to excess air and the ash pit loss due to unconsumed combustible, represent respectively about 50 per cent. and 10 per



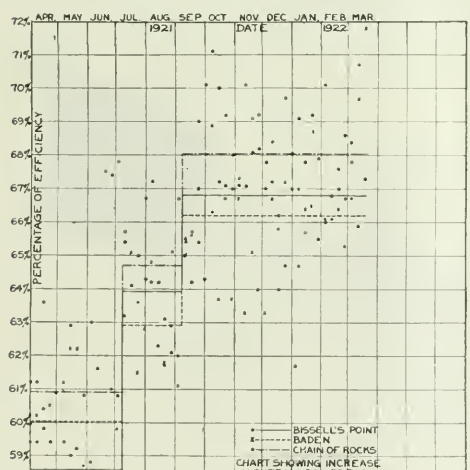
RESETTING OF BOILER FOR USE OF PULVERIZED COAL

cent. of the total losses of a present average good boiler setting with the common methods of firing, and the value of making a saving in these becomes very apparent.

Because of the very short periods that the pulverized coal firing apparatus was run at a combustion rate of less than two pounds of coal per cubic foot of combustion space, no conclusions could be drawn regarding the life of the furnace; but when a combustion rate of about three pounds of coal per cubic foot of combustion space was attempted, the furnace burned out completely in less than a day. An approximate heat balance showed that over 20 per cent. of the heat in the coal was lost in radiation through the walls of this furnace. With these results, and the furnace destroyed beyond repair, it was decided to rebuild under a Baden station boiler, the high setting of these boilers lending themselves far better to the adaption of a proper furnace. The illustration shows the new setting in longtudinal section.

CHANGE IN BASIS OF COAL CONTRACTS

A better grade of coal was used during the year, which result was secured by receiving bids on the basis of a guarantee of both B. t. u. value and percentage of ash, bids being compared on the basis of the B. t. u. delivered for one cent, this value being obtained by dividing the B. t. u. in the coal released for steam making by the price per ton plus freight plus hauling and unloading cost. In paying for the coal, the B. t. u. value for one cent was obtained as above but omitting the freight, hauling and unloading charges from the divisor, and this value was then used in determining the price per ton from the analyzed B. t. u. and ash content of the coal. The B. t. u. released for steam making in the type of furnaces in use was found to be about (100% minus half the ash per cent.) times the total B. t. u. of the coal. During the seven months this method was in operation the B. t. u. varied from a maximum of 11,277 to a minimum of 9,199, averaging 10,460; while the ash percentage ranged from a maximum of 24.1 to a minimum of 9.0, with an average of 15.2.



BOILER ROOM EFFICIENCIES, 1921-1922

The diagram shows the overall boiler room efficiency for the past fiscal year. The new coal is considered to be mainly responsible for the increase during the later months because of the low percentage of ash secured by the new specification. The ash averaged over 21% during April, May and June which, with combustible in the refuse of about 25%, incurred an ash pit loss of 10% of the heat in the coal. The ash of the coal delivered under the new contract averaged 15% and the combustible in the refuse about 15%, giving an ash pit loss of 3½% of the heat in the coal. The net resulting gain is about 6½% in the heat available for making steam, and assuming the heat absorption or efficiency of the boiler to be increased proportionately accounts for much of the increase shown in the diagram. The lines in the chart show a rise in efficiency for July and August, which was due to the fact that coal was obtained from the Duquoin district, which is superior coal to that previously used. The increase in September was due to the new form of contract, coal deliveries under this contract having been begun in that month.

NEW PUMPING PLANT

The new pumping plant to be constructed on the Missouri river already referred to is designed for a total capacity of 200,000,000 gallons daily and it is proposed to equip the plant with eight boilers, each of about 1,000 horsepower capacity, set high, with large combustion chambers that will accommodate either forced draft stokers or the burning of pulverized coal. The boilers will be equipped with superheaters and probably with economizers. Boiler efficiencies of 75% and over are to be anticipated, and to obtain the highest possible overall plant efficiency, the steam pressure and the temperature will be chosen as high as modern practice permits for the types of pumping units considered. It is proposed to use somewhere between 250 pounds gage pressure with 150 degrees superheat and 300 pounds gage pressure with 200 degrees superheat.

For the low-pressure pumps the turbine-driven, geared, centrifugal type of pump will be chosen as lending itself best for handling the raw sandy water. High-pressure units will be either the triple expansion, crank and fly wheel pump or the steam turbine-driven, geared, centrifugal pump, or a combination of the two.

The size of the high-pressure pumps and that of the pump conduit or rising main are inter-related. This rising main leads for 45,000 feet to the Stratmann Hill reservoirs. The friction head will, of course, vary with the size of this conduit and the annual steam cost will vary correspondingly—that is, the larger the main the less the friction head and the less the cost of steam and also the size of pump. A larger main will, of course, cost more than a smaller one, while decrease in the size of pump will reduce the cost of both purchase and operation. Consequently there will be a certain size of conduit and corresponding size of pump which will give a minimum total annual cost. Studies of this indicated

that the size will be somewhere between 66″ and 78″ diameter of main, depending mainly upon whether the steam cost will be approximately $.20 or $.40 per 1,000 pounds of steam. For a conduit having a diameter of 72″, the average between these limits, the total head on the pumps would be 351 feet, about 75 feet of which would be friction head.

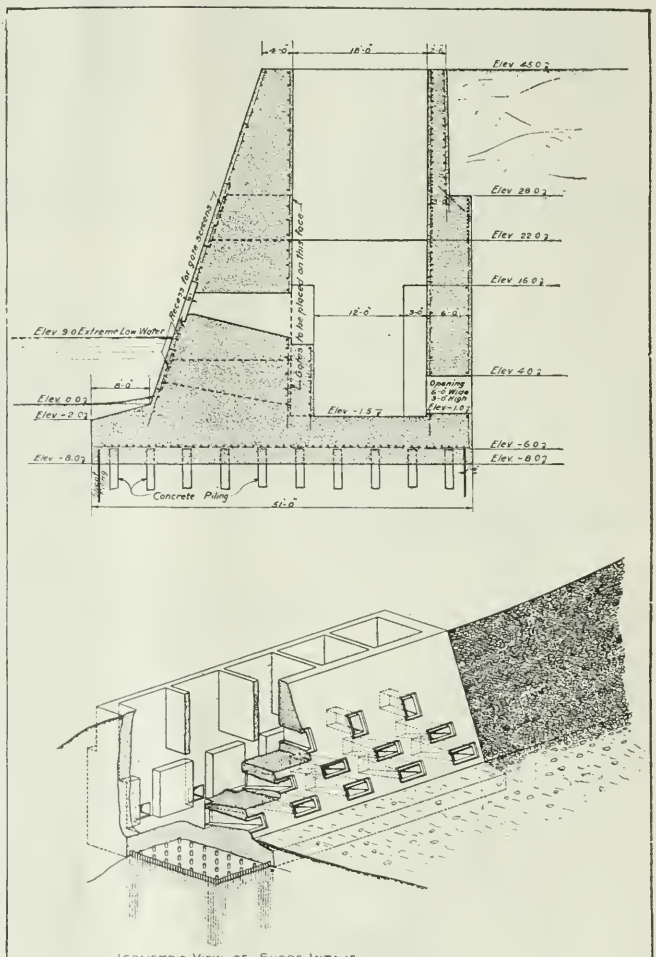
THE PROPOSED SHORE INTAKE

The new water works plant, where both pumping plant and purification plant will be located, it is proposed to locate at a bend in the Missouri river, on the concave bank of the same, thus bringing the channel close to the works, which will be located directly on the river bank. The current can be trained close to the shore by a small amount of regulation works, thus insuring deep water at a shore intake at all stages of the river, which will eliminate the possibility of ice and sand troubles such as the city now experiences annually with the intake towers in the channel. The river regulation is designed to maintain a deep channel in front of the plant at all stages of the river between the extremes of 9 feet and 43 feet. The regulation works will consist of a system of dykes extending from the north shore to within 500 feet of the south one and varying in height, allowing sufficient area for the river to pass along the south shore at all stages of the river without excessive velocity. The south bank will first be protected by short dikes and later, when the sections between these have filled to a smooth curve, this bank will be protected by revetment.

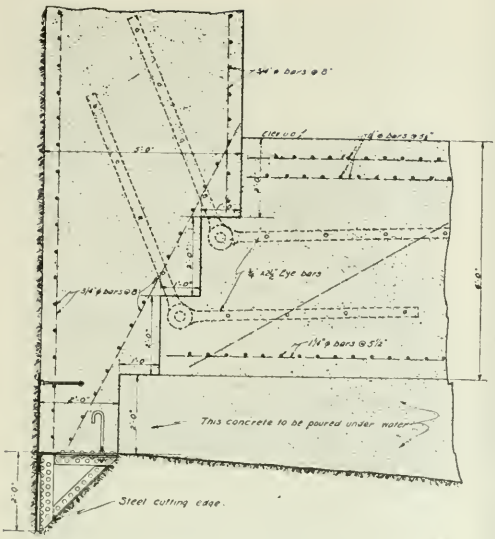
The shore intake is provided with ports arranged at three different elevations. The lower ports are rectangular, 3 feet high and 8 feet long and changing to a rectangular opening on the inside 6 feet high and 4 feet long, where suitable gates are provided. The small height of the ports on the river side gives the advantage of requiring 3 feet less depth of water than the ports of equal area in the existing intake towers, for the same submergence of the top.

It is proposed to build this intake wall in a cofferdam constructed of steel sheet piles 56 feet long. These piles will be drawn after the intake wall has been completed and each pile cut into four equal lengths and used as permanent curtain piling under the settling basin walls.

The pump pits are placed close to the intake, the low-service pit being connected to it by a separate concrete conduit for each pump. The pits will be of reinforced concrete 90 feet in diameter. It is proposed to sink them by the open caisson method, building up the sides of the pit as the caisson bottom sinks. Piles to resist both buoyancy and downward pressure are to be driven after the side walls are in place and the bottom of the pit sealed with plain concrete. On top of this a reinforced concrete bottom is to be constructed which will be attached to the side walls by means of eyebars. The general construction is shown by the accompanying illustration.



ISOMETRIC VIEW AND CROSS-SECTION OF SHORE INTAKE



SECTION THROUGH CUTTING EDGE OF LOW-SERVICE ENGINE PIT

The estimated cost of the new plant, including river regulation, buildings, purification plant, pumping plant, reservoir, mains and land, is $15,777,000.

PURIFICATION PLANT

No change was made in the purification plant or in the method of operating during the past year. A test is being made, however, to determine the best depth of sand for the filter and the best size of sand. Filter No. 19 is being used for this purpose. All the sand and gravel was removed from the filter, the strainer plates were cleaned and a gravel bed 22 inches deep was put in place. The gravel is in three layers, the bottom layer consisting of 1-inch gravel in a 5-inch layer, ¾-inch gravel in a second layer 15 inches thick, and the top layer 2 inches thick of 3/16-inch to ⅜-inch gravel. On this gravel will be placed sand of varying sizes and depths ranging from 12 inches to 24 inches. A careful analysis is being made of the results obtained with each depth of sand.

During the seven years' operation of the filters the sand has become coated to such an extent that after washing, the coating amounts to 10% of the weight of the sand. An experiment was made a short time ago of removing this coating by the use of a cement gun. The filter sand, after all the water had been drawn from it, was discharged through the cement gun against a steel plate. The sand rebounded from the plate and a great deal of the coating stuck to the plate, building up a hard bed of coating such as cement does in the normal use of the gun. Further experiments along this line are being continued.

During the year 39,540 million gallons were pumped to the purification plant by the low-service pump and 38,871 million gallons were filtered. There was added to this water 2,413 tons of sulphate of iron and 14,622 tons of lime, 2,732 tons of sulphate of alumina and 152,202 pounds of chlorine. There was removed from the water 208,459 tons of suspended matter and 12,991 tons of dissolved matter, and 27,020 tons of coagulants were precipitated; giving a total amount of matter removed of 248,470 tons.

This matter, most of which was deposited in the sedimentation basin, was flushed out through the sewer by opening mud gates about 6 inches for a half-hour period at varying intervals. Most of the deposit, however, was removed by teams at a total

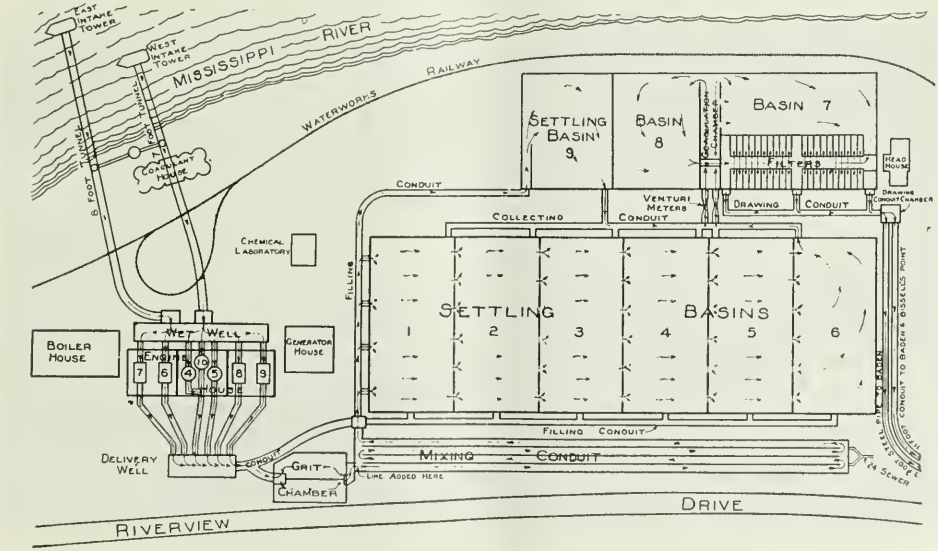


DIAGRAM SHOWING OPERATION OF PURIFICATION PLANT

cost of $9,262 for labor and teams, with a value of water used of $8,247.

After the water has passed through a grit chamber the lime is supplied at the entrance of the water into four mixing conduits, through which it passes in series, entering the western one first. These mixing conduits are rectangular in section, 7 feet wide, 11 feet deep and 2,388 feet long. They had been in service since they were constructed in 1915 without cleaning and a deposit of mud and scale had gradually formed and increased in quantity and hardness until a maximum depth of over 5½ feet was found in the west conduit, 4½ feet in the one next to it, and about 1½ feet of softer deposit in each of the others. The two western conduits were taken out of service about a year ago and cleaned. About 200 feet of the north end of the west channel was cleaned by hand, the deposit being so hard as to require a pick to loosen it for shoveling. The material was wheeled to the north end, hoisted and dumped into wagons. About 150 feet was cleaned by shoveling into a water jet discharging into a settling basin and later on the material was removed from the basin in the usual cleaning process. The remainder of the west channel and all of the adjacent channel was cleaned by flushing while a disc harrow, altered for use in the conduit, was pulled between manholes, located about 420 feet apart, by means of ropes attached to both ends of the harrow and passing over pulleys set in frames placed in the manholes at each end of the section to be cleaned. Two teams were hitched to the pulling rope and they traveled on top of the conduit in an opposite direction to the movement of the harrow in the conduit. When the harrow reached the end of the section it was turned, the ropes fastened on the opposite ends, the team turned and hitched to the rope which was the tag rope on the previous trip.

This method proved very satisfactory. The discs were turned to suit the kind of material encountered and the water was kept running about one foot deep, which swept the material loosened by the harrow into the sewer at the south end. The sections were cleaned in order from south to north. 3,250 cubic yards of material were removed, 380 cubic yards by hand at a cost of $2,199 and 2,870 cubic yards by flushing and harrowing at a cost of $1,201 for labor and approximately $124 for 10 million gallons of water used in flushing.

The mixing conduit in the new plant will consist of a number of short open conduits making 180 degree turns and capable of being run in series or parallel, to provide violent agitation of the water after lime and iron have been added for a period varying from 1 to 3 minutes; together with a few larger channels to provide gentle mixing for 20 to 40 minutes before entering the settling basins. The conduits will be open and cleaning may be accomplished by draining, flushing and scraping one section while the others are in service. This type has the advantage over the tunnel that it will save in materials. While the capacity of the latter is based on a velocity of 3.5 feet per second for 40 minutes, the proposed conduit will have a capacity based on 3.5 feet per second for 2 minutes and ½ foot per second for 40 minutes. Laboratory experiments have demonstrated that the proposed method of mixing is as effective as the one in use.

Risky Sewer Construction

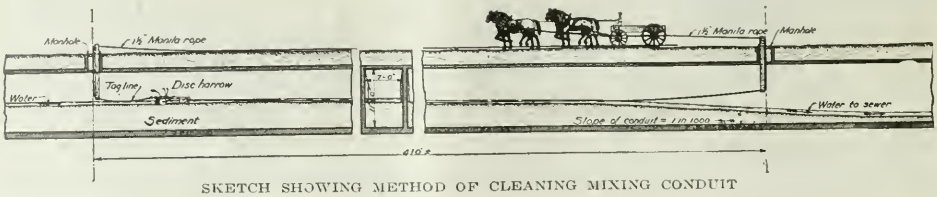
The latest annual report of the Bureau of Surveys of Philadelphia tells of the failure of a sewer, the details of which cause one to wonder not that the sewer failed, but that it stood up as long as it did. The sewer in question was 13 feet in diameter, built under the tracks of the Philadelphia & Reading freight yard, and consisting of only one ring of brick headers laid up in lime mortar. A section of this sewer 85 feet long failed and placed several tracks in the freight yard out of service and was, therefore, immediately repaired with more substantial construction.

That this sewer 13 feet in diameter and only one ring of brick in thickness did not collapse before must have been due to firmness of the soil, careful shaping of the bottom of the trench to fit the invert, and a careful compacting of the back-filling at the haunches and over the arch. Even with this and with the best possible workmanship in the brick laying, it seems wonderful that this sewer stood for so many years under the constant vibration of freight trains passing over it.

Cost of Meter Maintenance

The latest annual report of the municipal water works of Reading, Pa., gives the cost of operating and maintaining the meter system during the year in question as $8,221.69. The average number of meters in service during the year was 12,678, which gives a rate of 65 cts. per meter per year. This is made up of unit costs as follows: clerical service, 23.5 cts.; reading, 18 cts.; repairing, 17.5 cts.; delivering bills, 05.3 cts.; general maintenance, 00.6 cts.

This, it seems, covers actual payments made for repairs and reading, clerical service and delivering bills and general maintenance, but nothing for interest and depreciation of the meters. The report states that the cost per meter the previous year was 37 cts. greater, due chiefly to charging off old meters as scrap that year, while not any were charged off during the year covered by the report. It would seem to be more businesslike bookkeeping to distribute the amount charged off for worn-out meters



SKETCH SHOWING METHOD OF CLEANING MIXING CONDUIT

over all years in the form of depreciation rather than to concentrate it on occasional years, which results in figures for no one year giving a correct representation of the cost of the meter service.

Metering in Cleburne

Cleburne, Texas, a town of about 12,500 people, owns its water system, which is under the control of a Board of five Commissioners. The superintendent is J. W. Hockaday, who was employed by the Board about two years ago. The town was then about 65 per cent. metered and water shortage was continually threatening. During the last two years the remaining 35 per cent. of the services were metered. In spite of this, only about one-third of the water pumper was being accounted for. After careful consideration of the situation, Mr. Hockaday received permission to make a thorough inspection of the meters. The result of this inspection and the overhauling of the meter system is that the town has plenty of water, and although the pumpage has decreased about 33 per cent. the revenue has increased by about the same percentage.

Sludge Digestion at Birmingham

By L. H. Salter.*

Four and a half million gallons per day of very strong sewage passed through sedimentation tanks and contact beds, and the sludge digested two to three weeks, producing an equivalent to Imhoff sludge.

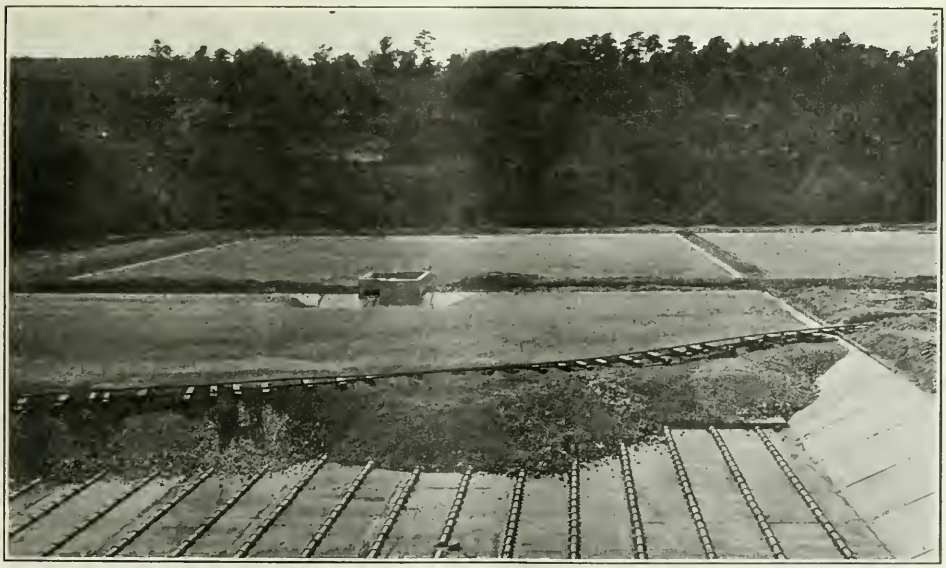
The sewage treatment plants of Birmingham, Ala., include a septic tank installation, sedimentation tanks, sludge digestion tanks, and contact beds. These handle the sewage from about 200,000 people, three-fourths of whom are connected to the sewers. The remainder are served by one of the largest box and can privy installations in the South, the scavengings from which are dumped into the sewers.

Birmingham lies in a long, narrow valley which is drained by two main streams — Valley and Village Creeks. Paralleling these creeks are two trunk sewers, named for the creeks along which they lie. These sewers were built by Jefferson County to serve the various municipalities which since that time have been consolidated into the city of Birmingham, or now compose its suburbs. These sewers, as well as the sewage treatment plants, are under the direction of the county sanitary engineer.

The network of city sewers discharge into these county trunk sewers. Nominally, the city is sewered on the separate system, but most of the lines are actually so leaky that in times of wet weather, the sewers flow under a head, with manholes spouting like geysers. This overload clogs the county trunks and, in turn, the sewage treatment plants are loaded far beyond their capacity.

The Valley Creek sewer is 12.53 miles in length

*Sanitary Engineer of Jefferson County, Alabama.

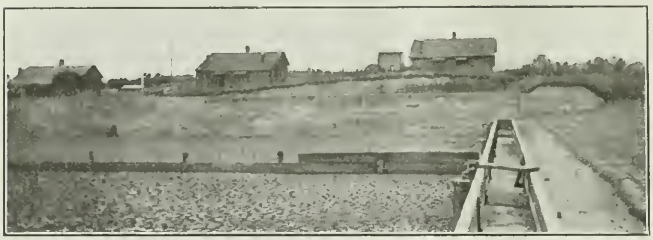


CONTACT FILTERS—SHOWING PARTS OF THREE OF THE FIVE BEDS

GENERAL VIEW OF ENSLEY SEDIMENTATION TANKS

and varies from 48 inches to 63 inches in diameter. It sewers an estimated population in Birmingham of 90,000, and in Bessemer of 10,000. The average daily flow of sewage is about 8,200,000 gallons, which is greatly increased during wet weather periods. The time of flow in the main is four to six hours, and the sewage is finely broken up, and at times becomes stale in its passage through the sewer.

The flow from the Valley Creek sewer is treated at a septic tank installation near Bessemer, known as the Bessemer Treatment Plant. This plant consists of 24 septic tanks, preceded by a screen pit and detritus tank, and followed by secondary settling tanks and strainer beds. These tanks have a depth of 13 feet, with a flat floor. The detention period is about 3 hours, with an average flow of sewage. No provision for sludge removal has been made other than to drain the tanks and remove by hand.



PARTIALLY DRIED SLUDGE ON SLUDGE BEDS
Note nearness of houses to the further bed

From the septic tanks the effluent passes to two large settling basins and then to 2.8 acres of contact beds. These contact beds have, however, been used merely as strainers since they were seriously damaged by a flood about two years ago. With the present equipment at this plant all out of date and overloaded, no repair work is contemplated.

With this treatment the effluent, of course, contains some suspended matter and is low in oxygen. Final discharge is into Valley Creek, which is heavily polluted with trade wastes, but which furnishes ample dilution. Sludge is removed about twice a year from the septic tanks, and dried on sludge beds.

THE ENSLEY TREATMENT PLANT

The Village Creek sewer varies in size from 20 to 36 inches, and is 10.4 miles long. It serves 45,000 people in Birmingham and 7,000 in the Ensley section. There are also dumped into the various sewers discharging into this trunk, the scavengings from approximately 4,500 box and can toilets weekly. This is one of the factors contributing to make strong and heavy the sewage carried by this trunk. The average daily flow is 4,500,000 gallons. An analysis of the sewage shows the following characteristics:

Total solids	982.
Suspended solids	532.
Dissolved solids	450.
Dissolved oxygen	1.0
Required oxygen	27.0
Relative stability	37.

This sewage is discharged into and treated by the Ensley treatment plant. The Ensley plant is a complete and rather unusual one. It consists of sedimentation tanks, sludge digestion tanks, and contact beds. The incoming sewage is passed through a combined screen and grit chamber, and then through a control chamber to the tanks. There are 24 sedimentation tanks, each 30 feet square, and having a maximum depth of 13.8 ft. These tanks are arranged in six ranks of four tanks each, giving a sewage flow distance of 180 feet and a retention period of 3½ to 4 hours under average flow conditions. The tank bottoms are hoppered with a slope of approximately 30 degrees, sloping into 45 degrees at the bottom. Sludge discharge is by hydrostatic head into small collecting chambers or wells, which are located in the center of each group of four tanks, whence the flow is by gravity to the pump sump.

There is no provision for reversing the flow in the tanks, so that the hoppers nearer the inlet receive the greater proportion of the settleable solids.

The tanks are operated as sedimentation tanks, and sludge is drawn from the six sludge collecting chambers at regular intervals according to schedule.

ONE END OF SLUDGE DIGESTION TANKS, SHOWING PUMP HOUSE

From the first pair of chambers serving the first 8 tanks, sludge is drawn every day; from the second set of chambers serving the third and fourth rows of tanks (the middle 8 tanks) sludge is drawn every other day; from the final pair of sludge chambers, serving the 8 final or outlet tanks, sludge is drawn every third day. The character of the sludge varies, of course, with the location of the tank, being of a much finer consistency at the outlet tank wells.

Analyses of the effluent of the sedimentation tanks show the following as an average:

Total solids	491.
Suspended solids	115.
Disolved solids	376.
Dissolved oxygen	1.4
Required oxygen	19.5
Relative stability	50.

Secondary treatment of the tank effluent is accomplished by means of 2½ acres of contact beds 5 feet deep constructed of furnace slag, 1 to 4 inches in size and placed in graded layers. Operation is by means of automatic controls furnished and installed by the Pacific Flush Tank Company. The operating schedules of the beds are with average flow:

Filling	1 hr, 50 minutes
Standing full	25 to 30 minutes
Emptying	2 hours
Standing empty	2 to 3 hours

The contact bed effluent shows the following characteristics upon analysis:

Total solids	371.
Suspended solids	50.
Dissolved solids	321.
Dissolved oxygen	1.2
Required oxygen	15.5
Relative stability	95.

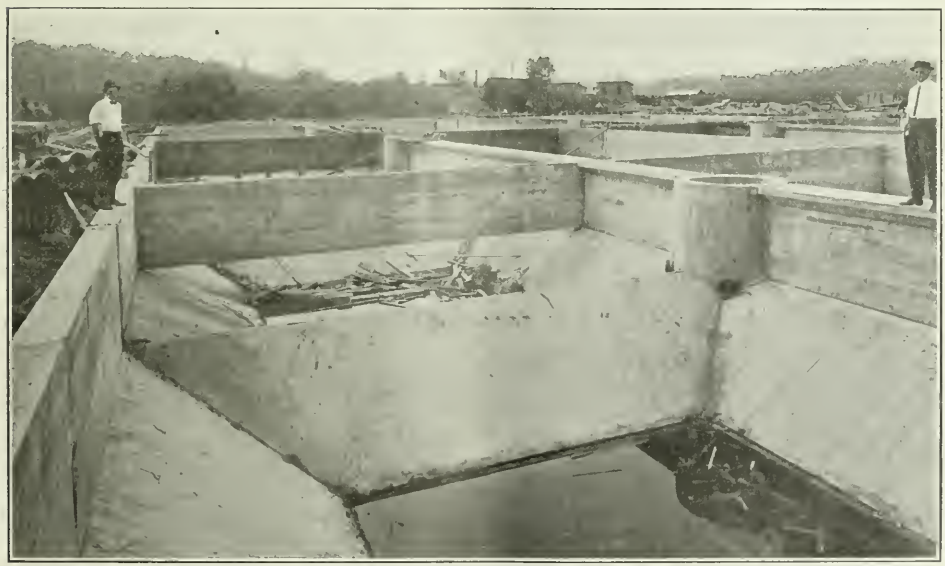
The experience with slag as a contact material has not been altogether satisfactory in Birmingham. After about 6 years of operation, the beds clogged badly. They were put out of service and the material removed and washed. In doing this it was found that there had been a slight amount of disintegration, which, with the tendency toward chinking or packing, owing to the use of various sizes of material, made too dense a bed. It is thought that the use of a single and large size—not less than 2 inches at least—of filter material would be advantageous, and this will be tried out in work planned for the near future. The use of other contact material will also receive consideration. Contact beds must be used, owing to lack of head necessary for sprinkling filters.

SLUDGE DIGESTION TANKS

One factor inhibiting the more general use of sedimentation tanks has been the problem of sludge disposal. This has been solved in a very satisfactory manner at Birmingham by the use of sludge digestion tanks. By means of these, a sludge is secured that is comparable with Imhoff sludge, that can be handled without difficulty, that is dried on beds within a hundred feet of residences, and that seems to have some value as a fertilizer.

As already stated, the sludge is drawn from the sludge wells at intervals of one, two or three days, the sludge being entirely removed at each drawing. From the sludge wells, the flow is by gravity to the pump pit, where it is screened and pumped into the sludge tanks.

There are ten of these sludge digestion tanks, eight of which are 13.5x15 feet and two 13.5 by 20 feet. This irregularity in size is due to the fact that the tanks are built over from some old septic tanks. The extreme depth is 12.5 feet. The bottoms are



SEDIMENTATION TANKS AFTER COMPLETION BUT BEFORE USE

hoppered with an 8-inch plug valve in the bottom of each tank. The digested sludge is pumped to the sludge drying beds.

The total capacity of the tanks is about 242,000 gallons. Sludge is retained in these tanks 14 to 21 days, depending mainly upon the weather and the degree of treatment given.

In four or five days, the sludge in the tanks begins to "boil" or digest. This continues for a few days, when a heavy scum forms. This is broken up with a stream from a hose, and the action allowed to continue. About the twelfth or fourteenth day, the working or turning process ceases and the heavier parts begin to settle. A clear liquor rises to the top.

Generally the settled sludge is too stiff to handle well with a pump, so the tank contents are again mixed, or water added, and the sludge pumped to the drying beds.

It should be noted that no attempt is made to reduce the moisture content of the sludge, but that the plan is to make it easy to handle and dry. However, there is actually a considerable reduction in moisture if the supernatant liquor is not mixed back with the sludge.

The sludge as it comes from the sedimentation tanks contains approximately 95% water. After 5 days of digestion this is reduced to 88%.

The sludge beds are two in number, 120x120 and 120x110 feet. They are composed of 4 inches of sand on 12 inches of slag, underdrained by 4 inch laterals, 4 to 6 feet apart.

The sludge is usually left on the sludge drying beds 15 to 30 or more days, depending on the weather. An analysis of the dried sludge yields the following average results:

Moisture	3.12
Available phosphoric acid	1.29
Insoluble phosphoric acid	.32
Total phosphoric acid	1.61
(Equal to bone phosphate of lime.	3.51)
Nitrogen	2.23
Equivalent to ammonia	2.71
Potash	0.33

This sludge is eagerly sought for by farmers and valued by them for its fertilizing values. It is used freely for fertilizing all sorts of plants and vegetables, apparently.

Controling Pollution of the Delaware

The Commissioner of Health of Pennsylvania, Edward Martin, and the Director of Health of New Jersey, J. C. Price, in July jointly signed an agreement between the Health Departments of those states, adopting a uniform policy as to the degree of treatment to be required for sewage discharge into the Delaware river, which forms the boundary between those states. This follows several months of inspection of the river made by the engineers of the departments and conferences between them upon the subject. The agreement signed by the departments is as follows:

Uniform Policy as to Degree of Treatment of Sewage Discharge into the Delaware River.
Adopted by the Departments of Health of the States of Pennsylvania and New Jersey.

1. Sewage discharged into the Delaware river from the northern limits of the States of Pennsylvania and New Jersey to a line above the city of Easton and the town of Phillipsburg shall be treated to such an extent as to produce a clarified and oxidized effluent; and also, that so far as legally possible, the State Department of Health will prevent the discharge of untreated industrial wastes into this portion of the river.

2. Sewage discharged into the Delaware river from a line above the city of Easton and the town of Phillipsburg to a line above the borough of Morrisville and the city of Trenton shall be treated to such an extent as to effect the removal of settleable matter by means of efficient sedimentation; provided, however, that in cases where such settled sewage may be discharged into this portion of the river that it may prejudicially affect a water supply, the effluent shall be further treated to adequately safeguard the purified water supply obtained from the river; and further provided, that when plans for sewage treatment works are approved, where the sedimentation of sewage is the only treatment required under this policy, the approval shall be subject to the condition that means for the further purification of the tank effluent shall be installed when deemed necessary by the State Department of Health; and also, that so far as legally possible, the State Department of Health will restrict the discharge of untreated industrial wastes which might be a menace to public health or create a nuisance to either sight or smell.

3. Sewage discharged into the tidal portion of the Delaware river, from and including Morrisville and Trenton and to and including Philadelphia and Camden, shall be treated by means of sedimentation and the effluent discharged through submerged outlets into deep water in the Delaware river; provided, however, that in cases where such settled sewage is or would be discharged into the said tidal portion of the Delaware river at such a distance above or below a waterwork's intake that it may prejudicially affect such water supply, the effluent shall be further treated to adequately safeguard the purified water supply obtained from the river; and further provided, that when plans for sewage treatment works are approved, where sendimentation of sewage is the only treatment required under this policy, the approval shall be subject to the condition that means for the further purification of the tank effluent shall be installed when deemed necessary by the State Department of Health.

3-A. From data now available it is considered that the discharge of only settled sewage into the aforesaid tidal portion of the Delaware river within two miles of a water work's intake of an efficient filtration plant may prejudicially affect such water supply.

4. In case the said point of sewage discharge is from one state and the said waterwork's intake is in the other state, so that the sewage effluent while discharged within the aforesaid two miles would have to cross the river to reach the water intake, then before a decision is reached by the State Department of Health having jurisdiction over the dis-

charge of sewage, the case shall be taken up with the other State Department of Health for a careful determination of the probability of the discharge of only settled sewage prejudicially affecting the water supply.

This agreement was signed on July 7 by Edward Martin, Commissioner of Health, for the Department of Health of Pennsylvania; and on July 13 by J. C. Price, Director of Health, for the Department of Health of New Jersey.

Disposal of Activated Sludge

By R. H. Eagles *

The use of sulphur dioxide gas has been tested at Houston, Indianapolis and Gastonia and appears to produce an ionic condition favorable to dewatering, prevent putrefaction and increase the ammonia content.

So many unsuccessful efforts have been made in the past few years to develop a commercially applicable method of dewatering activated sludge, that any new method which is advanced is met with a decided skepticism. The fact remains, however, that numerous small-scale and semi-commercial experiments have actually produced a dried product in suitable condition for use as a fertilizer. Furthermore, it has been definitely shown that this dried product has a considerable agricultural value, and can doubtless find a ready market demand if produced with some uniformity and in a dependable quantity at any given plant.

The extent of the marketability, the relative commercial fertilizer value, and the cost of continuous production, have not yet been determined, largely because no dewatering process has been able to operate uniformly for a sufficient period to supply reliable data on operating costs. There is every indication, however, that a reasonably economical dewatering process, satisfactory in other respects, will result in sufficient revenue to defray the cost of sludge disposal, and in some cases yield a profit to be applied against the operating expense of the aeration plant. In either event, successful sludge disposal will tend toward the more general adoption of the activated sludge process by inland cities, since it will result in a net operating cost more comparable with other treatment methods producing a similar purity of effluent.

The dewatering of raw activated sludge has been attempted with so many different types of apparatus, without any uniformity of results, that more recent efforts have been confined largely to the use of pretreatment or conditioning methods to convert it into physical condition more adaptable to dewatering by ordinary methods and equipment.

There are two chief factors governing the favorable physical condition of activated sludge for dewatering. The first is the ionic condition of the liquor, which should be so controlled as to yield a more or less porous or granular solid from which the excess water can find easy egress, when the sludge is pressed or drained. The second factor is the biologic condition of the solids. If activated sludge is allowed to become septic, or partially so, a decay will set in which leaves the sludge structure fragile, and any attempt to handle it will result in disintegration with the formation of finely divided solids which are difficult to dewater.

It is well known that fresh, well-aerated sludge is more amenable to dewatering than stale or partially septic sludge. In practise, however, it is difficult to control this condition with any uniformity. The remedy suggests itself to sterilize, or partially sterilize the sludge immediately after withdrawal from the settling basins, to yield a "bacterially stable" sludge—that is, one which will not decompose during the dewatering period.

Sulphuric acid has been found beneficial as a conditioning agent to produce the proper ionic effect, but it has only a slight sterilizing effect, due to the low concentration used, and the difficulties of securing a quick and thorough mixing with the sludge. Furthermore, the use of acid has not been found entirely satisfactory by reason of the close control required, excessive cost, difficulties in storage and handling, and corroding effect on equipment.

To secure the beneficial effects of sulphuric acid without the expense and other disadvantages, and in addition to secure a sterilizing effect, a process has been developed that utilizes sulphur dioxide gas, produced by the burning of crude sulphur as required. This is known as the Maclachlan process. Sulphur dioxide is a well-known germicide, and its action on activated sludge is to arrest putrefaction for a considerable period. Well treated samples have remained fresh and odorless for as long as three months. The gas also combines instantly with the water in the sludge with the liberation of the hydrogen ion, giving the electrolytic effect which produces a porous and granular sludge solid.

The advantages of the sulphur dioxide treatment are low cost, simplicity of application, and ease of control. Crude sulphur costs from $15 to $20 per ton delivered, and approximately 75 lbs. will treat the activated sludge from one million gallons of sewage. The economy over sulphuric acid will be obvious when it is considered that the burning of crude sulphur is frequently the first step in the manufacture of sulphuric acid, and to this must be added the other manufacturing costs plus the expense of shipment.

The simplicity of application lies in the fact that a gas does its own mixing by agitation. A treating tank has been designed which accomplishes thorough absorption of the sulphur dioxide, and enables a continuous treatment of the sludge at a high rate of flow.

The ease of control is due to a peculiar color change taking place, which is easily observed by even an unskilled operator. A well treated sludge is golden brown in color, while under-treated is dark brown to gray. An excessive treatment does no harm, within reasonable limits, and is practically impossible with properly designed units.

* Sanitary engineer, Maclachlan Reduction Process Co., Inc.

For best effects, the gas treatment is applied to the sludge immediately after its removal from the settling basins. Septic sludge is sterilized equally well, but the colloidal action will have progressed too far, as a rule, to yield a product amenable to dewatering. Fresh sludge after gas treatment should be promptly dewatered since the ionizing action is more or less temporary, as in the case of acid treatment. However, gas treated sludge has been held over for more than twenty-four hours, still maintaining its dewatering properties, probably due largely to the absence of bacterial decomposition.

From a fertilizer standpoint, the application of the sulphur-dioxide treatment is highly beneficial, since it prevents the loss of ammonia through bacterial decomposition and volatilization in the dryer. It also actually enriches the ammonia content of the finished product by dissolving a portion of the alkaline earth metals present in the sludge, passing them off in the effluent. Sulphuric acid, on the other hand, tends to throw out precipitated sulphates which appear in the final product as a solid diluent, thereby lowering the percentage of ammonia. This fact is rather clearly indicated in the last column of the following tabulation which shows comparative averages of a series of filter press experiments at Houston on raw sludge, acid treated and sulphur dioxide gas treated. It will be noted that the ammonia content after gas treatment is 1.5% higher than after the acid treatment, an increase of 31%. 976 lbs. of acid per ton of sludge solids was used in the latter. Assuming the same gross amount of ammonia is retained in both treatments, the percentage of ammonia in the final product would be 2.1% lower in the acid-treated product if all the acid added re-

Comparative Tabulation of Filter Pressing Experiments at the Houston, Texas, Activated Sludge Plant

	Moisture in feed to presses.	Moisture in press cake.....	Time to press one charge.....	Dryer evap. ratio	Ammonia content of dried sludge.
Raw sludge.....	98.6%	87.3%	4 hr. 40′	8.9	3.6%
Acid treated.....	98.6	82.7	3 hr. 33′	5.7	4.8
Sulphur dioxide gas treated....	98.9	78.7	3 hr. 19′	6.5	6.3

mained with the sludge solids. This checks fairly closely, allowing for some of the acid to go off in solution, as must actually be the case.

From a sanitary standpoint, the deodorizing properties of the sulphur dioxide treatment make the process a valuable addition to any activated sludge plant. One of the arguments advanced in favor of the latter is the freedom from operating nuisances around the plant. Surplus sludge is liable to accumulate around the plant at times, and it rapidly becomes septic and malodorous, particularly in warm weather. If all sludge is treated with sulphur dioxide immediately after withdrawal from the settling basins, it will remain odorless for a long period, and will not attract flies or vermin.

Careful study of the sulphur dioxide treatment at activated sludge plants located at Houston, Texas; Indianapolis, Ind., and Gastonia, North Carolina, has fully demonstrated its efficiency and economy as a conditioning treatment to put the sludge into shape for final dewatering. This is a highly important phase of the entire activated sludge problem, and its successful accomplishment marks a big advance in the art. Of equal importance, however, is the development of suitable equipment for completing the dewatering.

The filter press and the centrifuge, with various modifications, have received most of the attention thus far, although some attempts have been made at drying on sludge beds. The filter-press entails a high operating cost through labor requirements and cloth maintenance, and great difficulty has been experienced in producing a firm, dry cake with any uniformity. The centrifuge has been found to effect a low recovery of solids, and has not succeeded in turning out a very dry cake. It is also expensive to operate. Both of these machines are open to further objection, and cannot be said to be very attractive to the sewage plant operator.

Attention is now being directed toward the development of a new device, different in principle from both filter press and centrifuge, which will economically produce a solid cake suitable for final drying. The sulphur dioxide treatment has been found to produce an entirely different character of sludge structure which can be handled by simpler methods than heretofore possible. The objective is to develop a fool-proof machine which can be relied upon to operate with uniformity, and at a cost which will enable the entire dewatering operation to show a profit.

The final drying of the sludge has not received much attention to date, for the reason that there has been a scarcity of sludge produced in proper shape for drying. Such tests as have been made have brought forth no unusual difficulties, and it is reasonable to assume that most of the commercial types of dryers for organic materials, either direct or indirect, will answer the purpose. If the sludge cake can be produced dry enough, it is probable that air drying will be found feasible in many localities, particularly at the smaller plants.

To sum up, it is safe to predict that the rapid strides which have been made toward successful sludge dehydration in the past year will lead to an early solution of the entire problem. With this accomplished, the activated sludge process will find more favorable consideration from engineers in charge of new sewage treatment projects. The more general adoption of this process with the utilization of the sludge as a fertilizer will go far towards eliminating a considerable economic waste. The greater part of the fertilizer ingredients taken from the soil find their way eventually to human consumption and are eliminated in the two great forms of municipal waste—sewage and garbage. The successful reduction of municipal garbage for the production of a fertilizer material, and grease, has come through a difficult development period to a point here it is being handled at a profit in many cities. When the sewage loss is also eliminated through the perfection of the activated sludge process, we may expect to eventually achieve a fairly complete "fertilizer cycle," with the ensuing benefit to mankind.

PUBLIC WORKS.

Published Monthly
at 243 W. 39th St., New York, N. Y.

S. W. HUME, President J. T. MORRIS, Treasurer

Subscription Rates
United States and Possessions, Mexico and Cuba $3.00 year
All other countries 4.00 year
Change of Address
Subscribers are requested to notify us promptly of change of address, giving both old and new addresses.

Telephone (New York): Bryant 9591
Western Office: Monadnock Block, Chicago
A. PRESCOTT FOLWELL, Editor
FRANK W. SKINNER, Associate Editor

CONTENTS

SLUDGE DIGESTION TANKS AT THE BALTIMORE SEWAGE WORKS. Illustrated. By C. E. Keefer 97
War Material for Road Work 101
ST. LOUIS WATER WORKS OPERATION. Illustrated 102
Risky Sewer Construction 106
Cost of Meter Maintenance 106
Metering in Cleburne 107
SLUDGE DIGESTION AT BIRMINGHAM. Illustrated. By L. H. Salter 107
CONTROLING POLLUTION OF THE DELAWARE 110
DISPOSAL OF ACTIVATED SLUDGE. By R. H. Eagles 111
EDITORIAL NOTES 113
Sludge Digestion—Tight Joints in Pipe Sewers—Recent Sewerage Work—Sewage Effluents and Water Supplies—Weather, Strikes and Highway Programs—Trucks versus Highways.
Radio in Highway Work 116
Cement Production and the Coal Shortage 116
Cost of Road Rollers 116
Study of Tractive Resistance on Roads 116
STREET AND SEWER WORK IN CINCINNATI. 117
RESURFACING OLD PAVEMENTS 118
LOWEST AND BEST BIDDER 119
REGULATE MOTOR TRUCKS OR DESTROY THE HIGHWAYS, WHICH? By J. N. Mackall .. 120
CALCIUM CHLORIDE FOR SAND-CLAY ROADS 121
Sludge Digestion in Albuquerque 122
Money Available for Highways 123
Training Road Inspectors 123
Engineering Employment Service 123
Sanitary Engineers Wanted 123
Valuation Engineers Wanted 123
Highway Research Specialist Wanted 123
Appraisal Engineer Wanted 123
Fellowships in Highway Engineering and Highway Transport 123
TABULATED SEWERAGE DATA 124
Large Sewers Built in 1921 and 1922 124
Pipe Sewers Laid in 1921 and 1922 126
Details of Sewerage Systems 131
Chlorination of Sewage in Stratford 133
NEWS OF THE SOCIETIES 134
NEW APPLIANCES 136

Sludge Digestion Tanks

In this issue we describe what are probably the two largest sludge digestion plants in the country, those at Baltimore and Birmingham. In Baltimore the combination of sedimentation tank and sludge digestion tank has partly supplanted Imhoff tanks and the plans now under way contemplate the complete change of the Back River plant of Baltimore to this type of treatment. Birmingham years ago built a septic tank plant, but its latest developments have been towards the same type of treatment as Baltimore's, with the probability of future abandonment of the septic tank. A few other communities have adopted sludge digestion tanks, but so far as we know not more than twelve installations of these are to be found in service in the United States.

We have given considerable space to this method of treatment in this issue because it seems to us that the tendency during the next few years will be towards this as a substitute for the Imhoff tank, which has been the popular favorite during the past ten years or so. The advantages claimed for the sludge digestion tank are given at some length by Mr. Keefer in his description of the Baltimore tanks. In general the claim is that both the sludge and the effluent obtained by plain sedimentation and sludge digestion are equally as good as from the Imhoff tank, while the cost of construction is considerably less and both the cost and trouble of operation are less.

Apparently considerable remains to be learned concerning the operation of sludge digestion tanks and the best method of constructing them. For instance, in the Baltimore plant, two sets of tanks acted in directly opposite manners, digested sludge rising to the surface in one set and falling to the bottom in the other. Even with the present limited information, however, the results obtained would seem to be sufficiently encouraging to warrant more general adoption of this system, and certainly would seem to offer the greatest inducement for a further study of this type of sewage treatment appliance.

Tight Joints in Sewer Pipes

Years ago sewer pipes were laid in England with clay as jointing material. These joints, of course, were not or did not remain tight, but they were cheap. Because of its unreliability, no American engineers now consider using clay, but cement mortar is considered standard, even though the expense is greater.

In wet trenches, however, cement mortar joints made in the ordinary way seldom produce tight sewers. Moreover, unless the inspector is keenly on his job, the bottom of the joint is very likely to be neglected, even in a dry trench. The result is that cement mortar joints are seldom perfectly tight and frequently not even approximately so. It would seem that the time had come to make another step forward in the matter of sewer joints and secure joints that are really tight. The cost will probably be a little greater, as was that of the advance from clay to cement, but the step is desirable for sanitary reasons and may even prove economical, all things considered. For instance, leaky joints may admit so much ground water as to require doubling or treb-

ling the capacity of a sewage treatment or pumping plant.

The undesirability of admitting ground water through the sewer joints is now generally recognized, but there is another very urgent reason for tight joints where there is no ground water. This is to prevent the entrance of tree roots into the joints. Where moisture escapes from a sewer into dry ground, if there are poplars, elms or in fact almost any trees, in the vicinity their roots are likely to find the sources of moisture and, entering the joint, produce in the sewer masses of roots that will partially and sometimes entirely clog it. If there is no leakage from the sewer to moisten the ground, this will not happen no matter how near the trees may be.

Cities are spending from $4,000 to $30,000 a mile for pipe sewers. There are methods of obtaining tight joints throughout the entire sewer system which probably would not add more than $100 to $200 a mile to the cost. Where there is ground water there can be no question of the economy of making this additional expenditure, and the same is true where trouble from tree roots is anticipated. Taking into account that there are other reasons, such as avoiding pollution of the ground, or the saturating of the ground so as to permit settlement of the sewer and consequent deposits of sewage in the low points therein, we believe that engineers will do well to consider seriously whether it would not be advisable to adopt as standard practice some method which will insure reasonable tightness of sewer joints throughout the system.

Recent Sewerage Work

The recovery of highway work from the effects of the war has, it is generally recognized, been more rapid and complete than that of almost any other kind of public work. A certain amount of extensions and renewals of water works plants and distribution systems has been found necessary also, and much of it has already been performed or at least begun.

Apparently sewer work has not been considered so important, and it has been deferred still longer, probably waiting for lower prices or other more favorable conditions. This is indicated by the data which we have collected during the past month and which are published in this issue. Out of more than 1,500 cities, towns and villages of all sizes that have received our questionnaire, only about 260 have reported any sewerage work done during 1922 or 1921. A number of the communities did not reply to the questionnaire, and there is reason for thinking that in the majority of cases this was because there was no work to report. If we consider only those that reported in one way or another, we find that 100 of these took the trouble to inform us that no work had been done by them during the past two years. Moreover, the amounts done by those that did report are seen, in the majority of cases, to have been comparatively small.

While this showing for the past two years is a poor one, it is probable that the amount of work to be done in the future must necessarily be all the greater therefor. Our communities are not going to fall permanently behind in the essentials of civilization, although they may at times lag, and the collection, removal and disposal of sewage wastes is recognized as one of the essentials of modern civilization.

While the construction of sewage is taken for granted as an essential municipal work, sewage disposal plants have not yet been recognized as a common appurtenance of a sewerage system and probably very few realize how common they are becoming. We have in this office a list of about 2,500 sewage treatment plants, more than 1,600 of which are municipal plants. A great majority of these have been built during the past fifteen years, but comparatively few during the war, so that the average rate before then was probably in the neighborhood of 200 plants per year. Construction of treatment plants will soon be renewed and probably will continue until all existing systems where they are necessary have been supplied.

In later issues we will give some general summaries and details of the information which we have on this subject.

Sewage Effluents and Water Supplies

One of the problems being studied by the Federal sanitary engineers is the relative effects of sewage effluents of different degrees of impurity upon water filtration plants having intakes at different distances from discharge points of such effluents. In other words, given an effluent of a certain degree of strength as to both organic and bacterial content, and a certain degree of dilution of such effluent, how far must it be discharged from a water works intake if a filter plant is to handle safely the water obtained from the river at such intake; or, given the intake for a water filtration plant and a sewer outlet located a certain distance apart, what degree of purification must be secured in treating the sewage to avoid overloading the water filtration plant?

As stated elsewhere in this issue, the State Health Boards of New Jersey and Pennsylvania have adopted a uniform policy as to the polution that each will permit the cities of its state to discharge into the Delaware river. This agreement divides the river into three sections or lengths, one above the city of Easton, a second between Easton and Trenton, and the third known as the tidal portion below Trenton. Sewage discharged into the first of these stretches of river, which forms the attraction for many vacation resorts, must be so treated as to produce a clarified and oxidized effluent; that discharged into the middle stretch must have been so treated as to be freed of settleable matter; while in the tidal portion, sewage shall be treated by sedimentation and the effluent discharged through submerged outlets into deep water.

As to this third section there is a further provision that "where such settled sewage is or would be discharged into the said tidal portion of the Delaware river at such a distance above or below a water works intake that it may prejudicially affect such water supply, the effluent shall be further treated to adequately safeguard the purified water supply obtained from the river." For several months engineers of the two states have been acting together in making a study of the river and from the data available the health departments believe that if sewage which has been treated only by passage through a sedimentation tank is discharged two miles or more

from the intake of a water works plant, such effluent will not prejudicially affect the water supply. This distance applies when sewage outlet and water works intake are on the same side of the river. Where they are on opposite sides it is thought probable that, in some cases at least, this distance could be lessened, but no definite rule is stated and each case has to be considered on its own merits by a joint investigation made by the two departments.

Several years ago the engineers of the Federal government began an exhaustive study of this question in the Ohio river, but unfortunately the war interfered with the study before it was completed, and the result of the investigation has never been published, although preliminary conclusions therefrom were given out by one of the engineers. Other similar investigations are being carried on and information on the point referred to is being accumulated which will aid sanitary engineers greatly in reaching conclusions concerning this relation of stream pollution to the loading of water works filters. The problem is by no means a simple one, involving as it does the effect of volume and velocity of stream flow upon sedimentation, intermingling, oxidation through absortion of oxygen from the air, the action of animal and vegetable life in the river upon organic sewage matters, the element of time as it affects all of these, and other affecting agencies some of which are known and some of which are undoubtedly unknown as yet.

Weather, Strikes and Highway Programs

In spite of the fact that prices were fairly high, there was every indication that 1922 would be a record breaker in highway construction. It only needed the final passing of the bill renewing the appropriation of federal aid to confirm the states in their resolve to construct as much highway mileage as the supply of material and availability of efficient contractors would permit. However, as has happened in previous years, conditions have interfered to curtail the road building program. The railroad and coal strike, the first operating directly as well as indirectly and the latter indirectly, have already had some effect upon the ability of highway authorities and contractors to obtain materials for carrying out their road building programs and it seems extremely probable that within a few days, or weeks at the outside, the rail transportation of most road building materials will be entirely stopped, as open-top cars will be used exclusively for the hauling of coal as soon as coal becomes available in quantities at the mines. This condition affects the entire country.

In the east there has been another condition, that of the weather, which has seriously interfered with road construction. Over a considerable part of the Middle Atlantic states, and to a somewhat less extent to the north and south of them, rainfall has been so almost continuous for the past two or three months as to interfere seriously with road construction, keeping the subgrade continuously wet and soggy, so as to interfere with the proper placing of the paving material even when the actual rainfall did not prevent working upon it. As a consequence of this weather condition, road improvements in this section of the country have fallen considerably behind, but it was hoped that with the cessation of wet weather the total construction for the season might still be carried to record figures. However, the rain has not stopped falling as yet and, as already stated, there seems to be absolutely no escape from the conclusion that the transporation of highway materials will be seriously interfered with by the withdrawing of open top cars from that service if the coal strike is settled, or, if this strike is not settled, by the withdrawing of them from any service because of the railroad strike.

Trucks Versus Highways

The competition between the inventors and makers of armor-piercing projectiles and those who in turn produce armor which they cannot pierce, but which in turn is pierced by projectiles of later development, seems to have its parallel in the manufacturers of trucks and roads respectively. When five-ton trucks were found to be too heavy for certain classes of highways, heavier highways were built to meet this increased demand; but before even a large percentage of them had been so reconstructed the truck manufacturers were turning out ten-ton trucks and expecting the states and counties to provide highways that could carry *them*. There is no reason for thinking that trucks cannot be made to capacities of 20, 30 or even 50 tons if such capacities promise to be economical for transportation and the highway pavements can be made sufficiently strong to carry them.

The same thing but to a much less degree has been taking place in the railroad world, where locomotives have been increasing in weight and power and the rails to carry them have been necessarily made heavier and more strong and durable. In the latter case, however, the progression has been entirely in the control of one party and the increase in either locomotive or rail has been governed by careful calculation as to the ultimate economy, taking both into consideration. In the case of the truck and the highway, however, the cost of constructing and maintaining the highway is no concern of the truck manufacturer or user, since none of the cost comes out of his pocket, but all is paid either by the taxpayers directly or by traffic in general. There can be no question that the point will be reached, if it has not already been reached, when further increase in weight of truck and consequent cost of highway will cease to be economical, if all expenditures and profits are taken into consideration, and some authority should be given the power to limit the weight of truck, or else the truck users must be put in the position of paying such share of the cost of the highway as to cause them themselves to feel and heed the economical limit.

It has been said a number of times and by a number of those interested in the problem that highways should be made for the traffic and that, no matter what the traffic demands may be, the highways must meet those demands if it would not halt the progress of civilization. We do not believe that the taxpayers of the country will accept this dictum if the facts and logic are placed fairly and squarely before them.

Most of the attempts at solving the problem so far have been in the form of state limitations to the weight of trucks that will be permitted to use the highways of the state in question. Maryland is an illustration, and her limitation of the weight of trucks is explained and defended in an article published elsewhere in this issue by J. M. Mackall, chairman and chief engineer of the State Roads Commission.

One method of requiring trucks as well as other vehicles to pay in proportion to the use they make of the roads is by the gasoline tax, which has become quite popular within the past year or two, having been adopted in Arizona, Arkansas, Colorado, Connecticut, Georgia, Kentucky, Louisiana, Maryland, Mississippi, Montana, New Mexico, North Carolina, Oregon, Pennsylvania, South Carolina, South Dakota, and Washington. The Chief of the Bureau of Public Roads, in urging that sources of revenue for highways be adopted that would be paid by road users, states that $40,000,000 annually could be raised for road building and maintenance by a tax of one cent per gallon of gasoline.

Another method of bringing the economic limit home to the truck user is offered by Colorado. The Colorado Public Utilities Commission holds that truck owners have no right to make profit out of capital furnished by the taxpayers in the form of public highways. The Commission has recently handed down a decision denying motor trucks the right to use certain roads because they do not contribute their share towards the construction and maintenance of such highways, comparing them with the railroads, which pay much larger taxes and yet construct and maintain their roadbeds at no cost to the public.

This Colorado decision was made in passing upon transportation conditions in Eagle and Garfield counties, there being 68 motor trucks operating as public carriers that passed through these counties on their regular route, but which paid into the state treasury only $918 per year for the use of state and county highways. This was not only unfavorable to the counties, but it was shown to be unfair to a competitor of the truck lines, the Denver & Rio Grand Western Railroad, which paid $38,023 into the fund for public roads, which they do not use at all, and in general paid other taxes which made their total contribution to these two counties $153,869. The following paragraph is contained in the opinion of the Colorado Commission:

> Public convenience and necessity, by which must be understood the convenience and necessity of the people at large as contradistinguished from the convenience and necessity of a very small number of people who seek to derive a profit from the farmers' and homeowners' investment in roads, never contemplating that the truck driver should destroy that, to the cost of construction of which he contributed little or nothing, or that he should reap where he has not sown. When the taxing laws of this State are so amended that the truck driver operating over State highways shall contribute his due proportion to the cost of construction and maintenance of our highways, then, and only then, can this Commission regard his use, under proper conditions and restrictions, of a great tremendously expensive public facility of equal dignity and equal benefit to the people with moderate use thereof by the ordinary taxpayer.

Radio in Highway Work

State Highway Commissioner Frank Page of North Carolina has arranged to have installed in his office in Raleigh a radio broadcasting station, while receiving stations will be placed in each of the nine district offices. In this way the administrative force of the Commissioner will be able to get into immediate touch with the construction and maintenance engineers throughout the state and thus effect a saving of several hundred dollars a month in telegraph tolls and stenographers' services.

It is believed that no other state is using radio for this purpose. The equipment is part of the surplus war material which is being distributed and was offered to Commissioner Page and immediately accepted by him. Thus the equipment will be secured without cost to the state except that of installation. It was expected that stations would be in service by the middle of August.

Cement Production and the Coal Shortage

The Portland Cement Association calls attention to the fact that the cement industry, being the fourth largest consumer of coal in the country (over 7,000,000 tons being consumed by cement mills every year), is being seriously affected by the coal shortage. Many of the plants have to secure their coal from more distant mines than ordinarily, which increase the cost, which increase is likely to be reflected in the cost of cement. In fact, unless the strike is settled very soon many of the plants will have to shut down.

The industry is affected also by the railroad strike. The equivalent of 377,000 box cars of 50 tons capacity each were required to haul last year's cement output. Also, 3,000,000 sacks are used every year for shipping the cement and the textile strike is likely to cut down the supply of sacks.

Cost of Road Rollers

In a letting on July 19 by the State Highway Department of Kentucky, bids were received for a 10-ton roller with scarifier from nine firms. The bids ranged from $4,000 to $5,100 for a steam-driven roller, and from $3,045 to $5,490 for one motor-driven. One firm offered $450 credit for an old war equipment roller.

Study of Tractive Resistance on Roads

A bulletin of the Federated American Engineering Societies announces that initial results from an investigation of the tractive resistance of roads indicates that information will be secured of great value to the highway engineers, and users of motor transportation. The investigations are being carried on under the auspices of the recently created Advisory Board on Highway Research of the National Research Council with which the Bureau of Public Roads and Quartermasters Corps are co-operating. Dr. Hatt, who is on leave from Purdue University, is directing the work.

Street and Sewer Work in Cincinnati

Figures for 1921 showing cost of cleaning streets and catch basins by machinery and comparison with hand work.

The year 1920 saw some radical changes made by the Department of Street, Sewer and Catch Basin Cleaning of Cincinnati, chiefly from hand to machine methods of cleaning streets and catch basins. During this year auto flushers, auto sweepers, and auto eductors were introduced. Referring to this in his annual report, the superintendent of the department, Fred Maag, stated that the motorization of the various street cleaning apparatus served to decrease the size of the working forces and aided in meeting the problem of restricted appropriations. "The auto flushers have rendered wonderful service. Having a carrying capacity of three times the old horse-drawn flusher and with the use of centrifugal pumps, they can outwork the old style flusher many times, both in quantity and quality of work. Our statistics will show in comparison quite a saving in unit costs between the two types and methods of flushing." The figures referred to show in brief that the horse flushing done last year cost 12.4 cents per square or 26.2 cents including overhead (the word "square" is used in Cincinnati to designate an area of 16,000 square feet), while the auto flushers operated at a cost of 2.2 cents or 5.0 cents including overhead.

"Our auto sweepers and pick-up machines have given a good account of themselves, being particularly adapted to improved streets. The auto eductors or sewer basin cleaners have proved themselves worthy in every respect. The savings made through our motor street and sewer cleaning apparatus has justified the investment of the large sum necessary for their purchase. It will be only a short time until the savings made will approximate the purchase price paid for this equipment."

The unit costs for the various forms of street cleaning other than flushing during 1921 are given as follows: street sweeping, 50.2 cents per cubic yard or 89.4 cents including overhead. White wings, 43.4 cents per 1,000 square yards or 49.6 cents with overhead. (Equals $6.99 and $7.936, respectively, per square.) Broom gang, 32.5 cents per square or 37.7 cents with overhead. Gutters, 25.0 cents per square or 27.9 cents with overhead. Gutters after flushing, 25.2 cents per square or 28.1 cents with overhead. (For gutters, a square is taken as 400 lineal feet—probably the average distance between intersecting streets.)

In the details of costs of horse and auto flushing, we find that the total number of horse-days for the year with the horse flushers was 1,069, giving an average cost per square flushed of 12.4 cents, while the total overhead cost was $2,685, or 13.4 cents per square. The auto flushers went into service in May and the labor cost with them averaged 2.2 cents per square, while the overhead, which totaled $3,347 averaged 2.8 cents per square. It will be noted that in each case the overhead cost was greater than the labor cost.

With hand labor such as white wings and gutter cleaning, the overhead is naturally comparatively small. The cost per 1,000 square yards for white wing labor averaged 43.4 cents, and the overhead only 6.2 cents. For gutter cleaning, the average cost for labor was 25 cents and the overhead averaged 2.9 cents.

Catch basins were cleaned by both hand and auto eductor throughout the year, the latter having removed 3,239 cubic yards from 2,335 basins, while 4,050 cubic yards were removed by hand from 1,264 basins. The labor per basin cleaned is given as $5.507 by hand cleaning and $.979 by auto eductor, or $9.032 and $1.660, respectively, including overhead. Using the cubic yards removed as the basis, the unit costs for labor were $1.719 for hand cleaning and $0.705 for auto eductor cleaning, and for overhead were $1.100 and $0.491, respectively.

In comparing the cost of street cleaning in different cities it is not uncommonly difficult, if not impossible, to determine just what is included in each item of cleaning. For instance, does "hand sweeping" include the entire cleaning of the street without aid from sweeping machines or flushers, or is it supplementary to these? In other words, what is the total cost per unit of area or street length of keeping the street clean, including all of the processes and equipment used on this particular stretch of street? In Mr. Maag's report he has grouped together the various processes that operate together for cleaning a given area and the results are shown in the accom-

Cost of Labor and Overhead, per Square of 16,000 Square Feet, or 400 Lineal Feet, for the Years Ending December 31, 1920 and 1921

Operation	1920 Labor	1920 Unit with O'rhead	1920 No. of Squares Cleaned	1921 Labor	1921 Unit with O'rhead	1921 No. of Squares Cleaned
Total cost of flushing	$ .151	$ .325	.....	$ .022	$ .050	.....
Gutters after flushing	.194	.216	14,008	.252	.281	49,361
Removal of dirt	.169	.311	.....	.152	.272	.....
Total cost of cleaning, per sq	.514	.852	.....	.426	.603	.....
Gutters	.258	.288	50,562	.250	.279	46,304
Removal of dirt	.169	.311	.....	.152	.272	.....
Total cost of cleaning, per sq	.427	.599	.....	.402	.551	.....
Broom gang	.320	.368	88,223	.325	.377	104,351
Removal of dirt	.169	.311	.....	.152	.272	.....
Total cost of cleaning, per sq	.489	.679	.....	.477	.649	.....
White Wings	.728	.835	53,502	.772	.882	53,040
Removal of dirt	.169	.311	.....	.152	.272	.....
Flushing	.151	.325	.....	.022	.050	.....
Total cost of cleaning, per sq	1.048	1.471	.....	.946	1.204	.....
Total number of squares cleaned	.....	.....	206,295	.....	.....	253,056
Cu. Yd. of dirt per square	.....	.....	.365	.....	.....	.304

panying table. It would be a great aid to a comparison of these costs with costs in other cities if other superintendents would similarly combine those items of street cleaning operation that are employed co-operatively on given areas.

In the table it is noted that the total cost of cleaning streets where flushing is employed, including overhead, was 60.3 cents last year, of which the flushing itself was only 5 cents. Cleaning a street by broom gang, including removal of dirt, cost 64.9 cents per square or about 7 per cent. more than cleaning by flushing. Considering only the cost of the sweeping in one case, however, and the flushing in the other, we find that the former cost 7-1/2 times as much as the latter.

In the case of cleaning with white wings, the items of flushing and of removing dirt are charged at the same rate per square as in the other combinations, and in addition the cost of the white wings is given as 88.2 cents. The cost is increased over that of flushing alone by the difference between the cost of the white wings and the cost of sweeping up the dirt in the gutters after the flusher has passed, which is 60 cents a square.

Comparing the costs in 1921 with those in 1920, we find in the case of flushing a reduction of about 9 cents in the labor in 1921, but a reduction of 16 cents in the overhead. This probably is due chiefly to the fact that the number of squares cleaned was 3-1/2 times as great in 1921 as in 1920, thus distributing the overhead over a considerably larger area. This seemed probable because in the other cases the reduction in overhead is approximately the same as that in labor.

Mr. Maag makes a comparison of the labor cost of horse-drawn flushers and auto flushing, the latter of which was begun in May, 1921, which shows that the horse-drawn flushing cost for labor alone 12.4 cents per square, while auto flushing cost but 2.2 cents; or, including overhead, the cost was 26.2 and 5.0, respectively.

Resurfacing Old Pavements*

Methods reported by city engineers for renewing or covering worn wearing surfaces of concrete, macadam and other kinds of pavements.

CONCRETE PAVEMENTS

Richmond, Cal., uses paint coat of asphalt covered with screenings for resurfacing old concrete pavements.

Boulder, Colo., resurfaces with asphalt on concrete alleys.

Washington, D. C., has resurfaced a few concrete roadways with about 2 inches of sheet asphalt.

Chicago, Ill., in resurfacing concrete cleans the surface and paints it with A. C., and places 1½ inches of binder and 1½ inches of asphalt top, or 2 inches of asphaltic concrete in two courses, using penetration 38 to 60, depending upon the traffic conditions.

Chicago Heights and Freeport, Ill., resurface concrete with sheet asphalt, using standard specifications.

Des Moines, Ia., in repairing old concrete cleans out cracks and holes, paints the edges with Tarvia B, fills the cracks with mastic of Tarvia XC with coarse sand and gravel; sprinkling a thin layer of coarse sand over the top. Deep holes and depressions are cleaned out and hot Tarvia B brushed on and the hole filled with broken rock or granite. Hot Tarvia X is then applied with sufficient gravel to fill the interstices. More hot tar is applied and the surface is covered with coarse sand and gravel. "These patches hold very well and make a fairly acceptable surface."

Ottawa, Kan., resurfaces concrete with sheet asphalt.

In Baltimore, Md., concrete has been given a flush coat of Tarvia A applied hot at the rate of 0.6 gallon per square yard, then covered with gravel passing a ¾-inch ring at the rate of 70 pounds per square yard.

Owasso, Mich., resurfaces old concrete with 1½-inch binder and 1½-inch asphalt top.

Webster Grove, Mo., covers concrete with a light treatment of tar and pea sized gravel.

Kansas City, Mo., thoroughly cleans the surface, first repairing the pavement so as to bring it uniformly approximately 2 inches below the finished surface; then makes a very light application of A. C. and surfaces with 2 inches of asphaltic concrete placed hot and thoroughly rolled.

Camden, N. J., lays complete asphalt top with binder on old concrete pavements.

Roselle Park, N. J., repairs cracks with Tarvia X and covers the surface with Tarvia A and sand.

Port Chester, N. Y., applies asphalt and grits to old concrete pavements.

In Waverly, N. Y., the concrete is thoroughly washed, dried and swept clean and about ¾ gallon of Tarvia X to the square yard is put on with a force distributor and covered with a thin layer of pea sized screened gravel scattered evenly over the surface.

In Greensboro, N. C., city manager P. C. Painter has found "that in laying concrete pavements, due to their short life, it is advisable to lay them with a little greater gutter face than would normally be the case, so that they can be resurfaced later with either bituminous concrete, sheet asphalt, brick or any other type of material which traffic conditions at the time of resurfacing would seem to justify."

Perrysburg, Ohio, last year laid 3,500 square yards of asphaltic concrete on old 6-inch concrete pavement.

Ada, Okla., resurfaces concrete with rock asphalt.

Hugo, Okla., has resurfaced 5,000 square yards with rock asphalt.

Denton, Tex., has used a coat of asphalt, 0.2

*Continued from page 83.

gallon per square yard, covered with sand, with good results.

Oshkosh, Wis., builds most of its cement concrete streets with a tar-gravel-sand mat, which protects the concrete from wear and does not crack or disintegrate. Repairs are made by using a power oiler distributing Tarvia A or any good distilled tar and covering this with roofing gravel or fine crushed stone and sand. "This repair is very cheap and effective for light or medium residence traffic."

OTHER KINDS OF PAVEMENT

Lafayette, Ind., last year resurfaced about 15,000 square yards of sheet asphalt with 3-inch brick using asphalt filler.

Highland Park, Mich., resurfaced old asphalt block pavements with tarvia covered with fine crushed limestone and rolled.

Oberlin, Ohio, has resurfaced 3 blocks of asphalt block pavement which had failed after 9 years of service in two ways: On one block the old blocks were removed and replaced with cement concrete and 2 inches of bituminous concrete, while in the other 2 blocks the depressions in the asphalt block pavements were leveled up with bituminous concrete and the whole pavement then covered with 2 inches of bituminous concrete. This work was done 3½ years ago and is still in good condition without any repairs.

Des Moines, Ia., resurfaces over asphaltic concrete and bitulithic as follows: The surface is thoroughly cleaned by flushing and deep depressions are filled with low penetration A. C. close mix binder, and thoroughly rolled. The primer coat of asphalt cut back in naptha is applied and evaporated to stickiness. Then a course of very fine mix sheet asphalt, using a penetration A. C. of about 40, is applied to an average thickness of one inch and thoroughly rolled. City Engineer K. C. Kastberg says that streets treated in this manner in the spring of 1916 have shown up as good as standard sheet asphalt work. Union between the top and the old surface is very good. Care must be exercised to prevent puddles of the primer coat forming in slight depressions, as there is a tendency for them to bleed up where they are of much depth. The cost for this is about ½ the usual cost of resurfacing work.

In Altoona, Pa., bituminous pavements have been replaced with new reinforced concrete, as the city does not have any equipment for patching bituminous pavements.

MACADAM STREETS

The ordinary treatment of macadam streets is that of patching rather than resurfacing. However, some cities place new surfaces on old macadam.

Waukegan, Ill., lays brick on old macadam streets, shoulders 3 feet wide being constructed of old macadam material with 1½ gallons of asphalt per square yard applied by pouring.

Elkhart, Ind., resurfaced macadam streets with sheet asphalt in 1919, and Gary, Ind., has done the same.

Owensboro, Ky., during the past five years has resurfaced 9 miles of old macadam with bituminous concrete as follows: 2 inches of wearing surface is laid on 1½ inches of binder, with a flush coat over the finished surface. The aggregate is composed of Ohio river gravel, Ohio river sand and a very fine bank sand with about 10% of lime dust. The aggregate carries about 8% asphaltic cement, penetration about 55. The binder is laid quite close. City Engineer E. B. Shifley says that this construction is nearly perfect and is cheap and not a yard of the 9 miles has failed.

Rochester, N. Y., lays 2 inches of sheet asphalt on old macadam, specifications requiring that enough of the old material be removed to bring the pavement to the required grade and crown. The surface is then thoroughly cleaned of any organic matter and rolled with a 10-ton roller, then covered with a 1-inch binding course and 2-inch wearing surface of asphalt, both the standard sheet asphalt construction.

"Lowest and Best Bidder"

The State highway engineer of Kentucky, Joe. S. Boggs, has issued the following statement explaining a recent decision of the Highway Department to investigate the character of bidders as well as their bids:

"The laws of Kentucky give to the State Highway Commission the right to reject any or all bids at a contract letting, and require them in making an award to select the lowest and best bidder, the attention of all bidders being called to this in the advertisements of lettings to be held.

"For the past year, in addition to this, bidders whose work is unknown to the department have been required to file with their proposals a verified and sworn financial statement, a list of equipment, banking reference, and recommendations from those for whom they have formerly performed work. At some of the lettings held in recent months a few of the low bids have been rejected on account of a noncompliance with these provisions of the advertisement and award made to the contractor that the commission considered the best experienced and the most responsible. Contractors who have had their bids rejected for these reasons have sometimes seen fit to direct a great deal of censure against the officials of the department and have felt that they have been mistreated in the matter of award and that preference was being given to other contractors over them.

"In defense of this policy of the commission it is well at this time to state that because an individual or firm is low bidder on a contract at the time of letting it is no evidence that at the completion of contract they have been the best bidder. The commission owes it to the public in its selection of contractors to make its award to those that will give the highest type of service, that will inconvenience the traveling public the shortest period of time, and that will carry on the work with the least amount of engineering supervision.

"In order, however, that in the future there will be no further confusion in regard to the furnishing

of financial statements, lists of equipment, and experience records, there will be attached to each proposal a questionnaire which, when properly answered, will bring out not only the financial standing of the bidder but his past record as well. Any bidder not filling out this questionnaire will have his bid disqualified just the same as if he had failed to properly fill out the items embraced in the proposal.

"When it is shown that a bidder is not qualified to perform the work he is bidding on or has not sufficient funds to properly finance a project he will not be awarded a contract, and no apology will be made to him for the rejection of his bid. The public is entitled to the best service for the money that it invests in highway construction, and such service must not be impaired by the selection of contractors not capable of properly executing the work entrusted to them."

Regulate Motor Trucks or Destroy the Highways, Which?

By J. N. Mackall *

Maryland's experience and present laws and practice relative to heavy trucks.

It was the boast of one of the largest manufacturers of motor trucks a year ago that whenever a highway engineer brought out a new type of road his company brought out a type of truck heavy enough to destroy it. The competition between the road builder and the truck builder was an exact parallel to the competition which has gone on for ages between the safemaker and the burglar. Let us hope that always in road building, as in safemaking, the burglar has been just a little ahead of the safemakers.

Many more miles of usable highways are being destroyed every year by motor trucks carrying greater loads than those which the roads will stand than are being replaced in the same time, so that actually little or no progress has been made in most of the States in road building. Many States have records of roads constructed and destroyed before the first bonds for their construction had matured, and one Eastern State, at least, with which the writer is familiar, has roads which have been built three times from bond issues before the first bonds were paid off.

The motor truck manufacturer excused himself, as did the motor truck operator, by simply saying that the roads were not properly built, never for one moment admitting that the loads which went over them were perhaps greater than those which the roads would stand. The propaganda department of one of the large producers of a commodity entering into high grade road construction started the slogan a few years ago, "Build the road to carry the load." This slogan was extensively taken up and carried forward because it sounded so plausible. The writer took exception to it, and asked instead that a slogan be adopted, "Limit the load to one which the road will carry." Of course, this slogan did not get far, because it did not sound plausible, yet an analysis of the facts will show that it is absolutely essential.

The State of Maryland in 1918 paid dearly for the lesson which it later learned, but perhaps not too dearly. At that time trucks were permitted under the law with a maximum load of 28,000 pounds, and actually were permitted to carry any load they desired because no maximum limit was enforced. Consequently many loads of this capacity were carried and many larger. The main road in the State from Philadelphia to Baltimore to Washington was completely destroyed at many points and rendered practically valueless for its entire length because of the infinite number of breaks which came in it. Fortunately, the Legislature was in session at that time, and the public could be made to realize the great necessity for some effective regulation of motor truck traffic.

When it was proposed to limit the load to 20,000 pounds under any consideration, the manufacturers and users immediately set up a howl that industrial expansion of the country was being curtailed.

A study was made of the traffic which went over this road for a year preceding and during the time of the failure, and it was determined that if the loads carried on units of five tons or larger had been carried on units of three tons, and allowing the manufacturers' rated efficiency of the five-ton unit over the three-ton limit, the extra cost to the operators would have been $15,000. The cost of repairing this road was $600,000. Obviously, the State could no longer continue to spend $600,000 in order that a few persons might save $15,000.

The Legislature of 1918 enacted a law with three outstanding features in it:

(1) That no vehicle, of which the weight of vehicle and load combined exceeded 20,000 pounds, should be operated over the public highway at any time or under any condition.

(2) That the load coming on the road should not exceed 650 pounds per inch width of tire.

(3) That no vehicle should carry a load greater than that for which application has been made and fee paid.

The State Highway Department then felt that it was its duty to see that the law was enforced, and that whether it was practical or impractical of operation depended upon a strict enforcement of it, so that subsequent Legislatures could make whatever

* Chairman and Chief Engineer, State Roads Commission, Baltimore, Maryland.

changes were desirable. It is interesting to note here, parenthetically, that there has been no demand whatever on the part of the public operating trucks, or of dealers selling trucks in Maryland to increase these weights.

It has been clearly demonstrated previously that these heavy trucks could not be legislated off the road by high license fees. If it was desirable to get rid of them, then it must be done by positive and definite legislation, and enforcement of this legislation. The highway department equipped a crew with portable scales which could be used to weigh trucks at any point, and on the two main roads leading out of Baltimore, with permanent scales, on which all motor trucks were weighed.

The men in charge of the weighing of trucks were always accompanied by a uniformed officer from the Commissioner of Motor Vehicles, and all arrests and prosecutions were actually made by a uniformed officer. Every man whose vehicle was found to violate any of the outstanding features of the law was prosecuted, but this did not serve to effectively break up the practice of overloading. In many instances, it was more economical and satisfactory to the operator of the truck to pay a fine, if overloaded, than to discontinue the practice, so that in addition to prosecutions, the officers insisted upon the removal of all excess loads at the point where the arrest was made.

There was perhaps no positive authority to remove the overload. Neither is there positive authority for confiscating stolen property in the hands of the thief, but if the Legislature prohibited the carrying of a load in excess of 20,000 pounds, when a vehicle was detected with a greater load than this, it was obviously within the province of the State to remove the load greater than 20,000 pounds. In any event, no offender has ever seriously objected to or tested the right of the State to cause the removal of the overload. This effectively and quickly broke up the practice of overloading, so that now the State of Maryland finds this traffic less than .01 per cent. overloaded. The fine for overloading would perhaps run $10, $25 and in some cases $100, but this was very small in comparison with the cost of procuring another truck to come back and pick up the overload which had been taken off on the road, especially if the overload happened to be perishable commodities. The patrolman has compelled the removal of fresh beef from overloaded trucks in the month of July. However, it was not necessary to remove this but once.

The actual enforcing of the motor vehicle law has been responsible for the elimination of road failures in the State of Maryland. Since 1918 no road in the State has been permitted to fail. True, wear and tear have occurred, but actually no single instance of a road breaking up has occurred since the overloaded truck was put off the highway. Eternal vigilance may be the price of liberty, at least, it has been accepted as a fact for many years, but the public must be brought to a realization that eternal vigilance is the price it must pay for good roads. Financially, this country cannot stand long to build roads for the abuse of the user, but it can afford to build them for the use of the public, and we may go further and say that it cannot afford not to build them for the use of the public, but there is a difference between use and abuse. The difference is perhaps small in some cases, great in others, but it exists, and it is the right of every community to see that the roads which it has built are used and that they are not abused. If use without abuse in certain localities means the limiting of the gross load to five or six tons, then this must be done. It is certainly much more satisfactory from every point of view to limit the gross load down to six tons and carry it, than to let it go to ten tons or twelve or fourteen tons, and destroy the roads, so that they will not be of service to the potential truck operator or to the traveling public.

Much sentiment has swayed road building, road maintenance and road use. It is a business surrounded by cold hard facts and until it is accepted as such, and our road problem treated as a business and not a sentimental proposition, will we have made any steps toward solving it, and those who are responsible for the building and maintaining of the nation's highways must ascertain for themselves what is best to be done, and do it, and not be swayed by the truck manufacturer or the truck user, who desire to have roads built far beyond the ability of their neighbors to pay, in order that they may carry these very heavy loads when, where and how they please, with no regard for the economics of the situation.

Calcium Chloride for Sand-Clay Roads*

It is desired to call the attention of the maintenance engineers in particular and the highway commission in general, to an experiment with calcium chloride for dust laying and maintenance of gravel, sand-clay and top-soil roads.

Three half-mile sections of road, one each of gravel, sand-clay and top-soil have been selected near Raleigh for experimental treatment with calcium chloride. The gravel road section is on the Cary road and extends through the town of Cary. The sand-clay section is on the Wendell road just east of the corporate limits of Raleigh. The top-soil section is on the Fuquay Springs road beyond the experimental bituminous sections south of Raleigh. The first application of calcium chloride has been made on these sections and successive treatments will be made as deemed necessary.

Calcium chloride has been used extensively on gravel roads with considerable success in other States, but its use on sand-clay and top-soil roads has been very limited so that development of the experimental stretches on these types of roads will be watched with interest. The experiment is being conducted by the Division of Tests and Investigation under the direction of E. R. Olbrich, construction engineer.

Calcium chloride is a white deliquescent salt, and is obtained from two sources, namely (1) as a by-product in the manufacture of soda-ash, (2) from the salt brine pumped from underground streams in regions of salt deposits.

The term "deliquescent" is applied to those salts

* From "North Carolina Highway Bulletin."

which have the power of absorbing moisture from the air to such an extent that they are completely dissolved in the water thus formed.

Calcium chloride as a dust layer and maintenance material for gravel roads is not a new or experimental project. Connecticut, which has a large mileage of gravel roads, has used it successfully for many years. Leroy Ulrich, maintenance engineer of the Connecticut State Highway Department, has written many articles on its use on gravel roads. The Bureau of Public Roads, Washington, D. C., issues publications which deal with the use of calcium chloride on gravel and macadam roads. Michigan has used calcium chloride for a period of ten years in increasing amounts until at this time it is the generally accepted maintenance material for gravel roads in that State.

In the early use of calcium chloride it was shipped in liquid form in tank cars and applied to the road by sprinkling wagons. In more recent years it has been produced in the granular and flake forms. The flake form is best suited to road work, as it is possible to ship it in moisture-proof sacks of 100 pounds weight. In this form the material may be more easily handled and may be stored like cement until ready to be used, thus eliminating demurrage on tank cars.

When applied to the gravel road surface the individual flakes of calcium chloride attract and hold moisture, melting down into the road surface, leaving it with a damp appearance exactly as if a light rain had fallen. By storing a sufficient amount of moisture in the road surface it holds down the fine material which produces the dust nuisance, at the same time preserving the road surface by keeping the fine material in place on the road. It will be noticed on the gravel road treated with calcium chloride that, under the action of traffic, the gravel will pack down into a smooth firm surface. With repeated applications, and as the calcium chloride works into the surface, this result will become more evident. It will, however, not produce a hard crust or mat which later breaks through in numerous places, forming pot-holes and producing a very rough condition of road surface. Whenever necessary the gravel road surface treated with calcium chloride may be floated over with a drag, as there is always a sufficient amount of moisture present to make dragging effective at any time. The ease with which a smooth surface may be maintained on a gravel road with the use of calcium chloride and occasional dragging is one of the most important and unique features of the material, and one which appeals to the gravel road maintenance man.

Calcium chloride is more easily and cheaply applied, and can be successfully applied under less restrictions as to weather conditions and character of road surface than any other material, but there are certain limitations to the use of the material which should be understood. The surface of the road should be such that it will assist the calcium chloride in retaining the moisture attracted by it. For that reason, it is not advisable to apply it to a gravel road which has been previously treated with oil, until such time as the oil has lost its effect, and will not longer prevent the absorption of the calcium chloride into the road surface.

The question is often asked, "What is the effect of rain on a calcium chloride treatment?" Experience has shown that the calcium chloride is not washed from the gravel road surface by the rain, but rather it is absorbed into the surface like a blotter.

APPLYING FLAKE CHLORIDE

Calcium chloride in the flake form is easily and cheaply applied to the road by means of a lime spreader. The usual method is to load the material in sacks into a three or five-ton truck which has a lime spreader attached on the rear. A two-man crew is sufficient, one man driving the truck and the other man opening the sacks and feeding the material into the spreader. Ten miles, or more, of sixteen foot gravel road may be thus treated per day if the material is so located as to eliminate the necessity of the truck making long hauls.

In applying the material, the road should be shaped up in the spring after the frost is out of the road. Two treatments of calcium chloride are sufficient for the average gravel road in the Northern States and will cost from 2½ cents to 3½ cents per square yard, applied on the road, or at the rate of $250 to $350 per mile of sixteen foot road, per season, varying somewhat with the freight rate and local conditions. In the Southern States with a longer and hotter summer three treatments per season will probably be necessary. The repeated applications are not objectionable as each application is quickly and cheaply made, and it is not necessary to close the road to traffic during the application.

Calcium chloride is odorless and not objectionable from the standpoint of being tracked into the house or damaging the clothing of pedestrians. It has no effect on rubber tires. Laborers should wear canvas gloves and rubber boots in handling the material. If a lime spreader is used for applying the material it should be washed free of the salt after using, and the metal parts lightly coated with a thin oil to prevent corrosion.

Sludge Digestion in Albuquerque

Albuquerque, New Mexico, has voted the necessary bonds for constructing a sewage treatment plant and expects to start construction on the same this Fall or early next Spring. Plans that have been prepared call for two units of single-story sedimentation tanks 22 feet deep with hopper bottoms with a sludge digestion tank located between them. The group of three tanks will have outside dimensions of 100 feet by 90 feet. The sewage will be taken out from a 42-inch outfall sewer which at present discharges in the Rio Grande river and will pass through the two sedimentation tanks, from these into a mixing chamber and chlorination plant, and the effluent from these will be discharged back in the same 42-inch sewer near its outlet into the river. In addition there will be a sludge drying bed, to which the sludge will be pumped a height of 20 feet because of the swampy nature of the plant site. The plant is designed for the sewage from a population of 30,000 people, which will be entirely domestic.

Money Available for Highways

The Bureau of Public Roads has estimated that there will be available for highway construction during the coming year approximately $800,000,000, this including both federal and local funds. The states having available the largest amount include California with over $53,000,000, Pennsylvania with over $52,000,000, Illinois and New York with more than $47,000,000 each, and Texas with almost $43,000,000.

Training Road Inspectors

The State of North Carolina, in connection with the carrying out of its $50,000,000 highway program, has recently instituted a course of instruction for highway inspectors. The course is not an elaborate one but consists in taking the men into the laboratory for about a week to familiarize themselves with the different tests that are made of asphaltic and other road materials, and listening to lectures by highway engineers and others. The men are then taken to the asphalt plant and instructed in the duties of plant inspector, and then to the road for instruction as to the inspector's duties there.

Effort is being made to obtain inspectors from each of the highway districts for work in that district, thus permitting each man to serve as inspector in the district in which he lives.

Engineering Employment Service

An employment service for engineers who are members of the American Society of Civil Engineers, American Society of Mechanical Engineers, American Institute of Mining and Metallurgical Engineers or of the American Institute of Electrical Engineers is being conducted by the Federated American Engineering Societies. This service is in a position to supply engineers and technical men having every variety of training and experience to those who need them, or to assist such men to find positions. It is under the direction of W. V. Brown as manager of the Engineering Service Bureau, the office of which is located in the United Engineering Building, No. 29 West 39th Street, New York City. The service is free to employer and employee.

Sanitary Engineers Wanted

U. S. Civil Service Commission announces examinations for technical assistant, junior assistant and assistant in sanitary engineering, the salaries being from $1,500 to $1,800, $1,960, and from $2,500 to $3,250 respectively, with the bonus allowed by Congress of $20 per month. Applicants for technical assistant must have had a four years' college course two of which must have been devoted to special training in sanitary engineering, or eight years of study and experience in sanitary engineering. Applicants for junior assistant must have had, in addition to the above, not less than one year of post-graduate training or experience in sanitary engineering. Applicants for assistant sanitary engineer must have had two years of such post-graduate training or experience.

Valuation Engineers Wanted

The Civil Service Commission will receive applications until October 1 for valuation engineers in general mining, coal mining, oil and gas, and the forest industry. Their services will be used by the Bureau of Internal Revenue in connection with the income tax. Positions pay from $3,600 to $4,800 a year. There will be no written examinations, but ratings will be based upon education, training, experience and physical ability.

Highway Research Specialist Wanted

The United States Civil Service Commission announces a competitive examination for Highway Research Specialist, receipt of applications to close September 12. Grade I receives salaries of $1,800 to $3,000 a year, or $6.00 to $10.00 a day, and grade II receives $3,000 to $4,500 a year, or $10.00 to $12.50 a day. Applicants must have had at least six years' preliminary training in civil, structural, mechanical, electrical or chemical engineering, each completed year of an engineering course being considered equivalent to not more than eighteen months of experience. They must also have had at least three years' practical experience, of which at least one shall have been in the direction or performance of investigational work.

Appraisal Engineer Wanted

The United States Civil Service Commission announces an examination for Appraisal Engineer at a salary of $3,000 to $4,000, receipt of applications to close August 29. Applicants must have had training equivalent at least to graduation with a bachelor's degree in engineering, and four years of highly responsible engineering experience on buildings or other structures, at least one year in appraisal work within five years of the date of the examination.

Fellowships in Highway Engineering and Highway Transport

The University of Michigan will award two Fellowships not later than September 1 and two more not later than November 1, which Fellowships pay the sum of $250 with an allowance of $50 for expenses, and holders need not pay tuition fees. A Fellow must hold a bachelor's degree from a college of recognized standing and enroll as a candidate for the degree of Master of Science or Master of Science in Engineering. He must be in residence either from October to February, from December to March or from February to June. The Fellowships are known as the Roy D. Chapin Fellowship in Highway Transport, the Roy D. Chapin Fellowship in Highway Engineering and two Detroit Edison Fellowships in Highway Engineering. Information may be obtained by addressing Professor Arthur H. Blanchard, Engineering Building, University of Michigan, Ann Arbor, Michigan.

Tabulated Sewerage Data

From several hundred city engineers in all parts of the country, giving the amounts and kinds of sewers laid during 1921 and 1922, jointing material used in pipe sewers, and other details.

Comparatively little sewer work has been done since the war interfered with this and other classes of public work, and it has therefore been several years since this Journal thought it worth while to collect figures concerning the amount of this kind of work that had been done during the recent past, as it was our practice to do annually some years ago.

Even now sewer work has not resumed its former activity, to judge by the reports made to us by engineers of a considerable percentage of the more than 1,500 cities to which questionnaires were sent. Apparently the majority of these cities did no sewer work during 1921 and are doing none this year, several hundred stating this definitely, while an even great number apparently leave it to be inferred.

The important place which sewerage holds in the public works of the country, however, is apparent even during these years of meagre construction. With only the comparatively few cities reporting construction, the lengths recorded therein total nearly 7,000,000 feet. The greater part of this is sewer less than 24 inches diameter, this totaling about 5,600,000 feet. A considerable part of the remainder are large sewers, about 194,000 feet being brick sewers, 163,000 concrete sewers built in place without reinforcements, 104,000 concrete sewers with reinforcement, and 103,000 being segment block sewers. If we assume an average cost of $2.00 a foot, which is probably under the 1921 cost, including manholes and other appurtenances, we have a total of nearly $14,000,000 spent last year for constructing sewers in the comparatively few cities listed in the tables. This does not include what was spent for sewage treatment plants, sewage pumping plants, etc., nor for sewerage maintenance.

Comparing the kinds of sewers, the number of cities tabulated would certainly seem to be sufficient to indicate with considerable precision the present tendency as to materials. Taking the sewers built in place, which range from 24 inches to 156 inches, we find that there were 194,000 feet of brick sewers, 267,000 feet of concrete (nearly two-thirds of which was without reinforcement), and 103,000 feet of segment block sewers. We were somewhat surprised to find from these figures that such a considerable amount of brick sewers was still being laid as compared to concrete sewers.

In pipe sewers we find vitrified clay greatly exceeding cement concrete, the proportion being some-

(Continued on page 133)

Large Sewer Built in 1921 and 1922

City and State	Brick Sewers Dimensions	Brick Sewers Length	Concrete Sewers Without Reinforcement Dimensions	Concrete Sewers Without Reinforcement Length	Concrete Sewers With Reinforcement Dimensions	Concrete Sewers With Reinforcement Length	Segment Block Sewers Dimensions	Segment Block Sewers Length
Alabama								
Montgomery	....	....	....	....	60″	540	....	....
Illinois								
Danville	....	....	....	....	....	....	33″	1,570
	....	....	....	....	....	....	36″	560
	....	....	....	....	....	....	42″	900
	....	....	....	....	....	....	48″	760
Indiana								
Gary	24″ to 96″	19,860	30″ to 96″	88,510	30″ to 54″	5,200	....	....
Muncie	....	....	....	....	....	....	36″ to 30″	2,400
Kansas								
Pittsburg	....	....	....	....	96″	106	....	....
Kentucky								
Ashland	30″	1,650	....	....	....	....	....	....
	33″	2,650	....	....	....	....	....	....
	54″	500	....	....	....	....	....	....
	60″	750	....	....	....	....	....	....
	63″	1,700	....	....	....	....	....	....
Paducah	....	....	....	....	102″ to 96″	7,900	78″ to 42″	6,160
Maine								
Portland	....	....	....	....	36″ x 36″	221	....	....
Waterville	....	....	....	....	....	....	48″	650
	....	....	....	....	....	....	54″	340
Massachusetts								
Cambridge	....	....	....	1,162	....	....	....	....
Fall River	30″	206	....	....	....	....	....	....
	28″ x 42″	117	....	....	....	....	....	....
	26″ x 39″	4	....	....	....	....	....	....
Lawrence	36″	670	....	....	....	....	....	....
Lowell	16″ to 72″	133,400	....	....	....	....	....	....
New Bedford	....	....	....	....	....	....	30″	1,104
	....	....	....	....	....	....	33″	2,036
	....	....	....	....	....	....	36″	1,096
Pittsfield	....	....	....	....	30″	1,212	....	....
Springfield	....	....	....	7,400	....	....	....	....
Waltham	....	....	....	....	....	....	30″ to 42″	799
Worcester	....	....	72″	80	72″	1,208	....	....

Large Sewers Built in 1921 and 1922 (Continued)

City and State	Brick Sewers Dimensions	Length	Concrete Sewers Without Reinforcement Dimensions	Length	Concrete Sewers With Reinforcement Dimensions	Length	Segment Block Sewers Dimensions	Length
Michigan								
Kalamazoo	....	....	....	....	....	....	18″	2,000
	....	....	....	....	....	....	30″	4,734
	....	....	....	....	....	....	54″	2,969
Muskegon Hgts.	....	....	....	....	....	....	30″ to 48″	4,979
Pontiac	30″ to 48″	9,900	....	1,200	....	14,000	....	....
Sault Ste. Marie	....	....	48″	600	....	....	....	....
Grosse Pt. Farms	....	....	....	....	....	....	36″	1,700
Minnesota								
Faribault	....	....	....	....	....	....	36″	2,917
St. Paul	....	....	....	....	42″	3,600	....	....
Mississippi								
Hattiesburg	....	....	....	....	3′ x 10′	650	....	....
Missouri								
St. Louis	108″	546	....	....	144″	2,720	60″	1,000
	66″	90	....	....	96″	1,742	45″	3,995
	....	....	....	....	....	....	42″	900
Montana								
Billings	....	....	....	....	....	....	36″	1,840
Great Falls	....	....	....	....	....	....	....	150
Nebraska								
Lincoln	....	....	....	....	....	....	42″	216
Omaha	....	15,560	....	....	....	....	....	....
New Hampshire								
Concord	....	....	....	....	....	....	33″	473
New Jersey								
Freehold	....	....	18″ x 21″	700	....	....	....	....
New York								
New York	....	....	....	....	6′3″ x 12′	1,600	....	....
	....	....	....	....	5′ x 7′6″	800	....	....
	....	....	....	....	....	....	60″	1,392
	....	....	....	....	....	....	54″	1,982
Niagara Falls	42″	40	....	....	....	....	51″	1,724
	....	....	....	....	....	....	48″	1,081
	....	....	....	....	....	....	44″	846
	....	....	....	....	....	....	42″	689
	....	....	....	....	....	....	36″	271
	....	....	....	....	....	....	42″	317
Rochester	....	....	....	....	....	....	45″	1,456
	....	....	....	....	....	....	60″	1,085
	....	....	....	....	....	....	66″	385
	....	....	....	....	....	....	84″	835
Ohio								
East Cleveland	60″	406	....	....	....	....	....	....
	....	....	....	....	....	....	36″	1,566
Lakewood	....	....	....	....	....	....	33″	60
	....	....	....	....	....	....	30″	500
	....	....	....	....	....	....	30″	503
	....	....	....	....	....	....	36″	2,000
Maumee	....	....	....	....	....	....	42″	1,024
	....	....	....	....	....	....	48″	36
	....	....	....	....	....	....	51″	1,232
West Park	....	....	....	....	....	....	48″	966
	....	....	....	....	....	....	42″	610
Oklahoma								
Enid	....	....	....	....	....	....	48″	375
Oregon								
Astoria	....	....	....	....	....	440	....	....
Portland	....	....	....	26,308	....	27,125	....	1,398
Pennsylvania								
Altoona	....	....	....	....	54″ x 69″ to 156″ x 69″	3,078	72″	3,450
Chambersburg	....	....	....	....	48″ x 48″	300	....	....
Ellwood City	....	....	....	....	....	114	....	....
Glassport	....	....	....	....	....	....	....	325
Harrisburg	....	....	....	....	32″ x 34″	3,192	....	....
Meadville	....	....	....	....	66″ x 78″	2,240	....	....
Sewickley	....	....	....	....	....	....	78″	703
Rhode Island								
Pawtucket	33″	210	44″ to 60″	4,768	....	....	60″ & 66″	2,697
Providence	16″ to 24″	4,438	24″ & 28″	2,751	....	....	....	....
South Dakota								
Aberdeen	....	....	....	....	....	....	60″ to 90″	13,000
Watertown	....	....	....	....	36″ to 57″	15,700	27″ to 36″	900
Texas								
Beaumont	....	....	....	....	30″ to 36″	5,000	....	....
Virginia								
Fredericksburg	....	....	....	....	42″ to 60″	180	....	....
Richmond	60″	855	....	....	84″	1,500	30″ to 57″	12,700
Washington								
Everett	....	....	....	26,000	....	1,000	....	....
West Virginia								
Bluefield	....	....	48″ x 72″	500	....	....	42″	100
Wisconsin								
Janesville	....	....	30″ & 36″	3,293	....	....	....	....
La Crosse	....	....	....	....	36″ & 39″	1,822	30″ & 33″	806

Pipe Sewers Laid in 1921 and 1922

City and State	Length in pipe—Vitrified clay feet: Less than 24″	From 24″ to 36″	Larger than 36″	Cement concrete pipe—Length in feet: Less than 24″	From 24″ to 36″	Larger than 36″	Other kinds of pipe sewers: Kind	Size	Length in feet	Jointing material other than cement mortar
Alabama										
Montgomery	7,766	1,853	.....	.....	.....	.....	.....	....	....	none
Arizona										
Bisbee	350	....	.....	.....	.....	.....	.....	....	....	none
Miami	.....	....	.....	45,000	.....	.....	.....	....	....	none
Yuma	70,000	....	.....	.....	.....	.....	.....	....	....	.....
Arkansas										
Ft. Smith	2,300	....	.....	600	.....	.....	.....	....	....	none
Pine Bluff	47,300	....	.....	.....	.....	.....	.....	....	....	none
Arizona										
Nogales	2,400	....	.....	500	.....	.....	.....	....	....	none
California										
Alameda	6,000	....	.....	.....	2,000	10,500	.....	....	....	.....
Anaheim	4,100	....	.....	.....	.....	.....	.....	....	....	none
Burlingame	8,040	....	.....	.....	.....	.....	.....	....	....	none
Calexico	20,000	1,000	1,500	.....	.....	.....	.....	....	....	.....
Eureka	2,424	....	.....	.....	576	.....	.....	....	....	none
Napa	1,235	....	.....	.....	.....	.....	.....	....	....	.....
Palo Alto	6,773	....	.....	10,623	.....	.....	.....	....	....	.....
Parkeville	1,200	....	.....	.....	.....	.....	.....	....	....	none
Redlands	291,500	....	.....	.....	.....	.....	.....	....	....	.....
Santa Maria	5,300	....	.....	.....	.....	.....	.....	....	....	.....
South Pasadena	10,000	....	.....	.....	.....	.....	.....	....	....	none
Venice	12,255	....	.....	.....	.....	.....	.....	....	....	none
Visalia	8,095	....	.....	.....	5,604.5	.....	.....	....	....	.....
Colorado										
Monte Vista	1,600	....	.....	.....	.....	.....	.....	....	....	none
Connecticut										
Ansonia	3,600	....	.....	.....	.....	.....	.....	....	....	.....
Bristol	4,248	....	.....	.....	.....	.....	.....	....	....	.....
Hartford	15,758	....	....	.....	.....	.....	{ reinforced concrete { cast iron	....	754 92	asphalt composition
Middletown	8,200	....	.....	.....	.....	.....	Armco iron	....	4,000	.....
Stratford	100,000	50,000	.....	.....	.....	.....	.....	....	....	S. P. C. compound
Florida										
Jacksonville	2,107	....	.....	2,100	3,165	200	reinforced concrete	36x72	1,800	none
Lakeland	2 000	....	.....	.....	.....	.....	.....	....	....	.....
St. Augustine	38,000	....	.....	.....	.....	.....	iron	12″	500	.....
St. Petersburg	5,622	2,788	.....	4,396	2,903	2,634	cast iron outfall	20″	1,200	.....
Georgia										
La Grange	5,827	....	.....	.....	.....	.....	.....	....	....	.....
Newan	125	....	.....	.....	.....	.....	.....	....	....	.....
Idaho										
Boise	4,754	....	.....	.....	.....	900	.....	....	....	jointite
Pocatello	8,100	....	.....	.....	.....	.....	.....	....	....	none
Illinois										
Benton	106,833	3,323	.....	.....	.....	.....	cast iron	8″ to 18″	418	.....
Beardstown	12,000	....	.....	.....	.....	.....	.....	....	....	.....
Canton	1,729	....	.....	.....	.....	.....	.....	....	....	.....
Chicago	213,000	700	.....	.....	.....	.....	.....	....	....	.....
Crystal Lake	57,450	....	.....	.....	.....	.....	.....	....	....	.....
Danville	25,000	500	.....	.....	.....	.....	.....	....	....	none
Cala	3,000	....	.....	.....	.....	.....	.....	....	....	none
Edwardsville	540	....	.....	.....	.....	.....	.....	....	....	none
Glenview	21,600	1,600	.....	.....	.....	.....	.....	....	....	none
Morrison	3,166	....	.....	.....	.....	.....	.....	....	....	none

Murphysboro	3,200	1,470	....	.....	.....	.....	.....	....	....	.....
Waukegan	6,450	....	....	.....	.....	.....	.....	....	....	.....
West Hammond	4,200	....	.....	.....	.....	.....	.....	....	....	none
Indiana										
Bloomington	20,000	800	....	.....	.....	.....	.....	....	....	none
Fayette	51,142	1,522	.....	.....	.....	2,810	.....	....	....	none
Gary	22,525	2,280	.....	.....	.....	....	.....	....	....	.....
Huntington	....	....	.....	.....	.....	.....	.....	....	....	none
Logansport	3,500	....	.....	.....	.....	.....	.....	....	....	oakum and pitch
Muncie	16,950	2,000	.....	.....	2,400	7,400	.....	....	....	none
Michigan City	....	1,000	.....	.....	.....	.. ..	.....	....	....	none
Terre Haute	13,000	....	.....	.....	...	.. ..	.....	....	....	none
Iowa										
Cedar Rapids	16,875	....	.....	.....	.....	.....	.....	....	....	.....
Charles City	19,694	....	.....	.....	.....	.....	.....	....	....	none
Keokuk	1,000	....	.....	.....	.....	.....	.....	....	....	none
Preston	16,376	....	.....	.....	.....	.....	.....	....	....	.....
Kansas										
El Dorado	1,500	....	.....	.....	.....	.....	.....	....	....	none
Fort Scott	37,000	....	.....	.....	.....	.....	cast iron	12"	726	.....
McPherson	8,106	....	.....	.....	.....	.....	.....	....	....	none
Pittsburg	13,200	....	.....	.....	.....	.....	.....	....	....	none
Salina	11,500	....	.....	.....	.....	.....	.....	....	....	none
Topeka	17,743	2,225	.....	.....	.....	.....	cast iron (to flush tanks)	2"	8,003	.....
Kentucky										
Ashland	84,700	22,400	.....	.....	.....	.....	.....	....	....	.....
Ft. Thomas	1,000	....	.....	.....	.....	.....	.....	....	....	none
Madisonville	36,550	1,030	.....	.....	.....	.....	.....	....	....	none
Paducah	6,100	15,100	.....	.....	.....	.....	.....	....	....	.....
Louisiana										
Columbia	1,100	....	.....	.....	.....	.....	.....	....	....	none
Maine										
Augusta	10,241	....	.....	.....	.....	.....	.....	....	....	none
Gardiner	3,621	....	.....	.....	.....	.....	.....	....	....	none
Portland	7,578	4,775	.....	.....	221	.....	cast iron	8"	156	.....
Rockland	934	....	.....	.....	.....	.....	.....	....	....	none
S. Paris	400	....	.....	.....	.....	.....	.....	....	....	.....
Waterville	7,200	....	.....	.....	.....	.....	.....	....	....	.....
Maryland										
Baltimore	444,370	3,480	.....	.....	11,500 a	.....	Armco pipe	14" to 20"	1,200	bituminus compound
Hagerstown	65,000	....	.....	.....	.....	.....	.....	....	....	G. K. comp.; S. P. C. comp.
Massachusetts										
Andover	....	....	.....	.....	.....	.....	.....	....	....	G. K. compound
Braintree	1,500	....	.....	.....	.....	.....	.....	....	....	.....
Brockton	32,300	4,700	.....	.....	.....	1,350	.....	....	....	G. K. compound
Brookline	1,221	....	.....	.....	.....	.....	.....	....	....	asph., G. K. comp., sulph.
Cambridge	8,699	....	.....	.....	.....	.....	.....	....	....	none
Dedham	2,837	....	.....	.....	.....	.....	.....	....	....	.....
Fall River	9,004	....	.....	.....	.....	.....	cast iron	10" & 12"	94	none
Fitchburg	17,018	....	.....	.....	.....	.....	.....	....	....	G. K. compound
Haverhill	6,440	....	.....	.....	.....	.....	.....	....	....	none
Holyoke	5,500	....	.....	.....	.....	.....	.....	....	....	none
Lawrence	3,000	....	.....	.....	.....	.....	.....	....	....	none
Lowell	9,942	....	....	.....	.....	.....	.....	....	....	.....
Lyon	4,348	625	.....	.....	.....	.....	.....	....	....	none
Medford	9,975	....	.....	.....	.....	.....	.....	....	....	.....
Milton	4,000	....	.....	.....	.....	.....	.....	....	....	none
New Bedford	23,189	2,775	.....	.....	.....	.....	iron	8"	558	.....
N. Attleboro	....	....	.....	.....	.....	.....	.....	....	....	G. K. compound
Orange	328	....	.....	.....	.....	.....	.....	....	....	none
Peabody	....	....	.....	.....	.....	.....	.....	....	....	asphalt
Pittsfield	6,310	975	.....	... ..	.. ..	.....	Iron	48"	110	.....
Springfield	39,250	1,400	.....	.....	.....	.....	.....	....	....	none
Waltham	5,700	....	.....	.....	.....	.....	.....	....	....	G. K. compound
Worcester	1,940	4,800	.....	.....	.....	.....	.....	....	....	none

a—Includes sizes up to 60-in. diameter.

Pipe Sewers Laid in 1921 and 1922—(Continued)

City and State	Vitrified clay pipe—Length in feet			Cement concrete pipe—Length in feet			Other kinds of pipe sewers			
	Less than 24"	From 24" to 36"	Larger than 36"	Less than 24"	From 24" to 36"	Larger than 36"	Kind	Size	Length in feet	Jointing material other than cement mortar
Michigan										
City of Three Rivers	3,950	....	.....	.....	.....	.....	.....	....	....	.....
Escanaba	2,000	2,600	.....	.....	.....	.....	wood stave force main	16"	5,100	G. K. or Jointite in wet trenches
Grand Rapids	27,042	....	.....	40,212	2,830	.....	.....	....	....	none
Grosse Pt. Farms	10,817	3,224	.....	... .	.....	.....	segment block	36"	1,700	none
Iron Mountain	43,650	....	.....	.....	....	.....	cast iron	8"	1,850	G. K. comp. and Jointite
Kalamazoo	65,083	14,779	.....	.....	.....	.....	steel	20"	744	
Muskegon Hgts.	61,296	3,087	2,261	.....	.....	.....	.....	....	....	none
Mt. Clemens	3,719	....	.....	.....	.....	.....	.....	....	....	none
Pontiac	11,883	....	.....	6,000	4,390	11,396	.....	....	....	none
Sault Ste. Marie	800	1,600	.....	.....	.....	... .	cast iron	24"	862	G. K. compound
Minnesota							.....	....	....	none
Bemidji	2,200	....	.....	.....	.....	.....	.....	....	....	none
Cloquet	2,910	....	.....	.....	.....	.....	.....	....	....	none
Faribault	114,772	3,334	.....	.....	1,640	.....	.....	....	....	.....
Little Falls	9,000	1,500	.....	.....	.....	.....	.....	....	....	.....
New Ulm	6,525	860	.....	.....	.....	.....	.....	....	....	none
Red Wing	8,036	684	.....	.....	.....	.....	.....	....	....	none
Rochester	37,496	3,298	.....	.....	....	.....	.....	....	....	Jointite below water level
St. Paul	34,423	1,433	.....	.....	.....	.....	.....	....	....	none
Winona	44,745	....	.....	.....	.....	.....	cast iron	18"	400	bituminous filler
Mississippi										
Canton	1,800	....	.....	.....	.....	.....	.....	....	....	.....
Greenwood	1,500	....	1,200	.....	.....	.....	.....	....	....	.....
Hattiesburg	9,000	492	1,206	1,166	.....	.....	.....	....	....	none
Laurel	3,500	....	.....	.....	.....	.....	.....	....	....	none
Missouri										
Boonville	2,000	....	.....	.....	.....	.....	.....	....	....	none
Fulton	1,300	....	.....	.....	.....	.....	.....	....	....	none
Joplin	....	....	.....	112,935	12,379	600	.....	....	....	joint compound
St. Louis	27,800	5,570	.....	.....	.....	.....	.....	....	....	none
Sedalia	900	....	....	.....	.....	.....	.....	....	....	none
Montana										
Billings	41,849	1,090	.....	.....	4,167	2,541	.....	....	....	none
Great Falls	3,870	....	.....	.....	.....	.....	.....	....	....	none
Kalispell	6,200	....	.....	.....	.....	.....	.....	....	....	none
Lewistown	800	....	.....	.....	.....	.....	.....	....	....	none
Livingston	3,300	....	.....	.....	.....	.....	.....	....	....	none
Marshall	900	1,400	.....	.....	.....	.....	.....	....	....	none
Nebraska										
Fairbury	2,400	....	.....	.....	.....	.....	.....	....	....	none
Fremont	.....	....	.....	4,500	.....	.....	.....	....	....	none
Hastings	1,300	....	.....	2,210	.....	.....	.....	....	....	.....
Lincoln	96,016	2,507	.....	.....	.....	.....	.....	....	....	none
Omaha	163,543	17,080	.....	.....	.....	2,180	.....	....	....	none
Scottsbluff	7,093	....	.....	.....	.....	.....	.....	....	....	.....
Nevada										
Reno	....	....	.....	12,430	.....	.....	.....	....	....	none
New Hampshire										
Concord	2,588	745	.....	.....	.....	....	.....	....	....	jointite
Laconia	....	....	.....	.....	.....	.....	.....	....	....	none
New Jersey										
Bound Brook	9,071	1,280	.....	1,390	.....	.....	.....	....	....	none
Freehold	6,000	....	.....	.....	.....	.....	.....	...	...	jointite
Newark	15,600	....	.....	570	5,800	265	cast iron	12"	24	jointite
Phillipsburg	27,000	500	.....	.....	.....	.....	cast iron	12"	1,400	.....
								10"	200	

Rahway	5,400	....	.....	.....	.....	.....	.....	....	....	jointite
South Orange	4,000	....	.....	.....	2,000	.....	.....	....	....	jointite
Summit	4,150	....	.....	.....	.....	.....	.....	....	....	jointite and G. K.
Wallington	12,967	....	.....	.....	.....	.....	.....	....	....	.....
Westfield	....	....	.....	.....	.....	.....	.....	....	....	G. K. compound
New Mexico										
Albuquerque	2,000	....	.....	.....	.....	60	.....	....	....	none
Roswell	1,670	....	.....	.....	.....	.....	.....	....	....	none
New York										
Auburn	....	....	.....	.....	.....	.....	.....	....	....	bituminous compound
Endicott	1,700	....	.....	.....	.....	.....	.....	....	....	none
Geneva	3,500	....	.....	.....	.....	.....	.....	....	....	.....
Hudson Falls	1,200	....	.....	.....	.....	.....	.....	....	....	.....
Jamestown	....	....	.....	.....	.....	.....	.....	....	....	none
Lackawanna	7,171	....	.....	.....	.....	.....	.....	....	....	.....
Little Falls	2,400	....	.....	.....	.....	.....	.....	....	....	.....
Lockport	1,800	....	.....	.....	.....	.....	.....	....	....	.....
Mamaroneck	15,000	....	.....	.....	.....	.....	cast iron	....	17,000	G. K. compound
Newark	2,000	....	.....	.....	.....	.....	.....	....	....	.....
New York	3,500	....	.....	.....	.....	1,200	{ cast iron { wooden barrel	18″	600 2,600	none
Niagara Falls	39,936	3,386	.....	.....	2,788	7,157	tunnel	6″x5″	410	none
N. Tonawanda	1,020	....	.....	.....	.....	.....	.....	....	....	.....
Ogdensburg	500	....	.....	.....	.....	.....	.....	....	....	none
Poughkeepsie	7,690	300	.....	.....	.....	.....	.....	....	....	.....
Rochester	79,127	584	.....	.....	.....	.....	steel	72″	1,010	bituminous compounds
Tarrytown	2,500	....	.....	.....	.....	.....	.....	....	....	none
Wilson	29,124	....	.....	.....	.....	.....	.....	....	....	none
North Carolina										
Asheville	68,000	....	.....	.....	.....	.....	.....	....	....	G. K. compound
Greenboro	15,678	....	.....	.....	.....	.....	.....	....	....	.....
Kingston	2,100	2,400	.....	.....	.....	.....	.....	....	....	none
Lexington	....	....	.....	.....	.....	.....	.....	....	....	G. K. compound
Reidsville	18	....	.....	3	.....	.....	cast iron	....	....	.....
Rocky Mount	27,400	3,600	.....	.....	.....	.....	.....	....	....	none
Washington	17,294	3,951	.....	.....	.....	.....	.....	....	....	.....
Wilson	44,561	548	.....	.....	.....	.....	cast iron	6″	72″	none
North Dakota										
Fargo	9,758	....	.....	.....	.....	.....	.....	....	....	none
Mandan	....	....	.....	.....	.....	.....	.....	....	....	jointite
Ohio										
Alliance	14,500	500	.....	.....	1,000	3,500	brick	66″	300	.....
Bellefontain	2,400	....	.....	.....	.....	.....	cast iron	12″	800	.....
East Palestine	....	....	.....	.....	.....	.....	.....	....	....	none
East Cleveland	4,692	....	.....	.....	.....	.....	.....	....	....	.....
Elyria	10,130	....	.....	.....	.....	.....	.....	....	....	none
Findlay	15,000	....	.....	.....	.....	.....	.....	....	....	none
Fostoria	....	....	.....	.....	.....	.....	.....	....	....	none
Lakewood	13,614	3,672	1,416	.....	.....	.....	.....	....	....	none
Lancaster	5,500	2,250	.....	.....	.....	.....	.....	....	....	none
London	3,600	....	.....	.....	.....	.....	.....	....	....	.....
Marietta	2,936	....	.....	.....	.....	.....	.....	....	....	.....
Marysville	....	....	.....	.....	.....	.....	none	....	....	none
Maumee	4,510	1,415	.....	.....	.....	.....	.....	....	....	none
Niles	....	1,600	.....	.....	.....	.....	cast iron	{ 10″ { 8″	450 450	.....
Troy	3,500	....	.....	.....	.....	.....	.....	....	....	none
West Park	38,050	5,582	.....	.....	.....	.....	.....	....	....	.....
Wooster	5,260	90	.....	.....	.....	.....	.....	....	....	none
Zanesville	17,030	1,700	.....	.....	.....	.....	.....	....	....	sewertite
Oklahoma										
Bartlesville	72,800	270	.....	.....	.....	.....	.....	....	....	none
Chickasha	5,440	....	.....	.....	.....	.....	.....	....	....	none
El Reno	3,200	....	.....	.....	.....	.....	.....	....	....	none
Enid	19,273	....	.....	.....	.....	.....	cast iron	8″	93	none
Lawton	1,700	....	.....	.....	.....	.....	.....	....	....	none
Muskogee	10,890	....	.....	.....	.....	.....	.....	....	....	.....
Oregon										
Astoria	....	....	.....	18,850	424	.....	.....	....	....	.....
Corvallis	....	....	.....	16,900	.....	.....	.....	....	....	none
Marshfield	1,700	....	.....	.....	.....	.....	.....	....	....	none
Portland	162,779	2,761	...	256,382	2,404	.....	.....	....	....	none
Salem	4,500	none this yr.	.....	.....	.....	.....	.....	....	....	.....

Pipe Sewers Laid in 1921 and 1922—(Continued)

City and State	Vitrified clay pipe—Length in feet: Less than 24″	Vitrified clay pipe—Length in feet: From 24″ to 36″	Vitrified clay pipe—Length in feet: Larger than 36″	Cement concrete pipe—Length in feet: Less than 24″	Cement concrete pipe—Length in feet: From 24″ to 36″	Cement concrete pipe—Length in feet: Larger than 36″	Other kinds of pipe sewers: Kind	Other kinds of pipe sewers: Size	Other kinds of pipe sewers: Length in feet	Jointing material other than cement mortar
Pennsylvania										
Altoona	11,142	837	.....	.....	1,759	551	.....	....	....	none
Beaver Falls	600	....	.....	.....	.....	.....	.....	....	....	.....
Bethlehem	9,771	5,633	.....	.....	.....	3,258	.....	....	....	none
Chambersburg	6,000	....	.....	.....	.....	.....	.....	....	....	none
Clariton	6,000	650	.....	.....	.....	.....	iron	....	60	.....
Clearfield	1,900	1,800	.....	.....	.....	.....	.....	....	....	.....
Connellsville	5,142	....	.....	.....	.....	.....	.....	....	....	none
Easton	3,782	494	.....	2,364	372	.....	.....	....	....	.....
Ellwood City	8,000	....	.....	300	.....	.....	.....	....	....	.....
Glassport	2,500	4,000	.....	.....	.....	.....	.....	....	....	bituminous filter
Greensburg	4,295	334	.....	.....	.....	.....	.....	....	....	none
Greenville	1,500	....	.....	.....	.....	.....	.....	....	....	.....
Harrisburg	15,496	850	.....	.....	.....	.....	.....	....	....	.....
Luzerne	543	....	.....	.....	.....	.....	.....	....	....	none
Meadville	1,574	....	.....	.....	.....	.....	.....	....	....	.....
Middletown	500	....	.....	.....	.....	.....	.....	....	....	none
Monongahela	1,785	....	.....	.....	.....	.....	.....	....	....	.....
Nanty Glo	2,080	....	.....	.....	.....	.....	.....	....	....	none
New Castle	6,505	....	.....	.....	.....	148	.....	....	....	none
Onlontown	10,500	....	.....	.....	.....	.....	.....	....	....	none
Parkesburg	1,098	....	.....	.....	.....	.....	.....	....	....	none
Rankin	....	....	.....	.....	.....	.....	.....	....	....	none
Sewickley	2,000	....	.....	.....	.....	.....	.....	....	....	none
Wilkinsburg	2,000	2,000	.....	.....	.....	.....	.....	....	....	.....
Rhode Island										
Providence	21,116	....	.....	.....	.....	.....	.....	....	....	.....
Pawtucket	18,276	263	.....	.....	.....	.....	.....	....	....	none
South Carolina										
Orangeburg	36,582	1,321	.....	731	202	.....	.....	....	....	.....
South Dakota										
Aberdeen	14,000	8,000	.....	.....	.....	.....	.....	....	....	none
Sioux Falls	23,000	4,735	.....	.....	.....	.....	cast iron	10″	1,733	
								6″	214	none
Watertown	98,450	5,350	85	2,680	1,050	.....	cast iron	16″	4,800	asphalt and sand
Yankton	2,452	....	.....	.....	.....	.....	.....	....	....	.....
Tennessee										
Clarksville	8,500	....	.....	.....	.....	.....	.....	....	....	none
Dyersburg	3,000	500	.....	.....	.....	.....	.....	....	....	.....
Muirfreesboro	600	....	.....	.....	.....	.....	.....	....	....	.....
Texas										
Amarillo	62,200	....	.....	.....	.....	.....	.....	....	....	none
Beaumont	5,000	....	.....	4,000	.....	.....	cast iron	12″	100	.....
Brownsville	3,000	....	.....	.....	.....	.....	.....	....	....	none
Brownwood	110,880	....	.....	.....	.....	.....	cast iron	....	500	.....
City of Lufkin	6,000	....	.....	.....	600	.....	.....	....	....	none
Denton	7,861	....	.....	.....	.....	.....	.....	....	....	none
Ennis	3,000	....	.....	.....	.....	.....	.....	....	....	.....
Mineral Wells	13,200	....	.....	.....	.....	.....	.....	....	....	none
Navasota	47,000	....	.....	.....	.....	.....	.....	....	....	none
San Benito	7,626	....	.....	.....	.....	.....	.....	....	....	filtite
Utah										
Provo	16,400	....	.....	.....	.....	.....	.....	....	....	.....
Vermont										
Barre	1,200	....	....	.....	.....	.....	.....	....	....	.....
Virginia										
Charlottesville	4,800	....	.....	.....	.....	.....	.....	....	....	none
Fredericksburg	2,960	....	.....	.....	.....	.....	.....	....	....	.....
Harrisonburg	....	....	.....	.....	.....	.....	.....	....	....	G. K. compound
Richmond	65,116	....	.....	.....	.....	.....	.....	....	....	none
Staunton	5,000	....	.....	.....	.....	.....	.....	....	....	none
Suffolk	7,220	....	.....	.....	.....	.....	.....	....	....	.....

Washington										
Aberdeen	....	....	.....	68,000	2,100	.....	.....	....	....	.....
Bellingham	....	....	....	14,720	.....	.....	.....	....	....	.....
Centralia	3,000	....	.....	.....	.....	.....	.....	....	....	none
Everett	....	....	.....	26,000	2,700	.....	.....	....	....	none
Pryallap	....	....	.....	29,540	.....	.....	.....	....	....	none
West Virginia										
Bluefield	42,000	....	.....	.....	.....	.....	.....	....	....	.....
Fairmont	4,000	....	.....	.....	.....	.....	.....	....	....	none
Moundsville	660	....	.....	.....	.....	.....	.....	....	....	none
Wisconsin										
Janesville	43,607	....	.....	.....	66	5,832	.....	....	....	none
Moinette	5,723	....	.....	.....	.....	.....	.....	....	....	.....
La Crosse	34,628	1,219	.....	.....	1,047	775	.....	....	....	.....
Lake Geneva	4,000	....	.....	12,987	2,000	.....	.....	....	....	.....
Rhinelander	none	none		.....	.....	.....	.....	....	....	none
Sparta	900	447	.....	.....	.....	.....	.....	....	....	.....
Wisconsin Rapids	10,000	....	.....	.....	.....	.....	.....	....	....	none
Wyoming										
Sheridan	7,800	....	.....	.....	.....	.....	.....	..	....	none

Details of Sewers Laid in 1921 and 1922

City and State	Sanitary sewers, feet	Storm sewers, feet	Combined sewers, feet	Surface water inlets: With catch basins	Surface water inlets: Without catch basins
Alabama					
Montgomery	3,047	7,112	....	96	....
Arizona					
Miami	45,000	....	....	....	....
Arkansas					
Ft. Smith	600	2,300	....	600	....
California					
Alameda	....	....	12,500	....	....
Anaheim	4,100	....	....	....	....
Burlingame	7,675	345	....	....	....
Calexico	20,000	....	2,500	....	....
Eureka	2,147	853	....	6	....
Napa	....	....	1,235	10	....
Palo Alto	6,773	10,623	....	51	....
Parkeville	1,200	....	....	....	....
South Pasadena	10,000	....	....	....	....
Visalia	....	....	....	18	....
Connecticut					
Ansonia	1,600	2,000	....	9	....
Hartford	....	....	16,076	....	....
Middletown	8,200	4,000	....	12	....
Florida					
Jacksonville	2,107	7,598	....	42	....
Lakeland	2,000	....	....	....	....
St. Augustine	30,000	8,000	....	84	....
St. Petersburg	9,610	9,933	....	....	77
Illinois					
Beardstown	....	....	12,000	....	....
Calla	....	....	....	4	....
Canton	716	....	10,126	....	....
Danville	15,500	....	9,500	....	150
Murphysboro	....	4,670	....	....	62
Waukegan	6,450	....	....	....	....
West Hammond	....	....	4,200	25	....
Indiana					
Bloomington	3,000	800	...	8	....
Lafayette	....	....	...	83	28
Logansport	....	....	....	14	....
Michigan City	....	....	1,000	35	25
Muncie	....	....	.. ..	200	....
Wabash	....	....	.. ..	397	....
Iowa					
Cedar Rapids	....	2,237	...	1,440	....
Charles City	19,694	....	....	....	....
Newton	....	....	....	30	....
Kansas					
Eldorado	500	800	....	5	....
Ft. Scott	37,720	....	....	....	....
Salina	10,000	1,500	....	....	....
Topeka	15,625	4,343	....	20	....
Kentucky					
Ashland	51,500	....	62,850	224	297
Ft. Thomas	1,000	....	....	6	....
Madisonville	35,990	1,690	....	27	12
Paducah	21,200	....	14,050	....	70
Maine					
Augusta	....	....	....	14	....
Gardiner	3,621	....	....	....	....
Portland	....	220.67	125,090	1,605	....
Rockland	934	....	....	....	....
South Paris	....	....	....	10	....
Waterville	....	....	....	12	....
Maryland					
Baltimore	408,750	51,800	....	....	602
Massachusetts					
Brockton	20,000	13,650	....	35	....
Brookline	1,221	1,152	....	12	....
Cambridge	5,216.1	4,644.6	....	23	....

Details of Sewerage Systems (Continued)

City and State	Sanitary sewers, feet	Storm sewers, feet	Combined sewers, feet	Surface water inlets: With catch basins	Surface water inlets: Without catch basins
Massachusetts (Continued)					
Dartmouth	....	3,200	....	26	....
Dedham	2,837	....	....	....	....
Fall River	3,206	108	6,110	....	....
Fitchburg	12,569	4,449	....	....	....
Haverhill	1,780	1,840	2,780	25	....
Holyoke	....	....	5,650	40 to 50	....
Lawrence	525	....	2,475	15	....
Lowell	....	....	....	3,972	....
Mansfield	....	....	....	25	....
Medford	7,457.95	2,517.05	....	21	....
Milton	4,000	....	....	....	....
North Attleboro	....	....	....	113	....
Pittsfield	....	....	....	31	....
Springfield	4,400	12,300	31,350	....	150
Waltham	3,416	2,484	....	20	....
Worcester	5,353	2,675	....	10	90
Michigan					
City of Three Rivers	1,950	2,000	....	18	....
Grand Rapids	46,233	2,130	21,721	....	....
Iron Mountain	....	....	....	5	10
Kalamazoo	35,723	29,360	....	50	400
Mt. Clemens	2 519	1,200	2 519	396	....
Muskegon Hgts.	51,248	15,397	....	46	74
Pontiac	39,969	18,086	....	222	18
Grosse Pt. Farms	....	7,340	8,401	7	26
Minnesota					
Bemidji	2,200	....	....	....	....
Faribault	90,863	31,800	....	150	20
Little Falls	5,000	....	5,500	8	....
New Ulm	....	....	6,525	....	....
Red Wing	8,036	....	684	....	....
Rochester	....	6,490	....	943	641
St. Paul	6,139	....	33,435	....	....
Mississippi					
Laurel	1,500	2,000	....	7	....
Missouri					
Boonville	4,000	....	....	....	....
Fulton	1,300	....	....	....	....
Marshall	900	1,400	....	6	....
St. Louis	4,305	....	39,158	110	39
Montana					
Billings	28,090	23,397	....	56	96
Great Falls	1,290	2,580	....	52	....
Kalispell	6,200	....	1,000	10	4
Livingston	1,700	1,600	....	10	....
Nebraska					
Fairbury	2,400	....	....	....	....
Hastings	3,510	....	....	....	....
Lincoln	95,923	2,600	....	....	24
Omaha	....	....	....	....	900
Scottsbluff	7,093	....	....	....	....
Nevada					
Reno	....	....	....	245	....
New Hampshire					
Concord	....	1,455	2,315.5	....	....
Laconia	....	....	....	950	....
New Jersey					
Bound Brook	10,461	1,280	....	6	1
Rahway	5,400	....	....	....	....
Freehold	6,000	700	....	....	....

City and State	Sanitary sewers, feet	Storm sewers, feet	Combined sewers, feet	Surface water inlets: With catch basins	Surface water inlets: Without catch basins
Ohio					
Alliance	2,000	17,800	....	120	....
Bellefontaine	3,200	....	....	....	....
East Cleveland	1,803	406	2,889	30	5
Elyria	3,620	7,510	....	52	....
Findlay	3,500	5,500	6,000	30	....
Lakewood	6,780	9,241	4,807	34	50
Lancaster	3,200	....	4,550	22	12
London	3,600	....	....	....	....
Marietta	2,476	460	....	2	4
Maumee	....	5,925	....	43	....
Niles	2,000	....	....	....	....
West Park	6,136	6,200	31,296	90	....
Wooster	4,260	1,000	....	2	....
Zanesville	18,730	....	....	....	....
Oklahoma					
Bartlesville	72,060	740	....	....	....
Chickasha	2,140	3,300	....	18	....
El Reno	3,200	....	....	....	....
Enid	19,366	375	....	....	112
Lawton	900	800	....	....	....
Muskogee	1,060	9,830	....	11	....
Oregon					
Astoria	....	....	19 714	300	....
Corvallis	....	7,800	3,000	120	....
Marshfield	....	....	1,700	22	....
Portland	....	....	479,152	....	847
Pennsylvania					
Altoona	8,234	5,280	7,304	17	....
Beaver Falls	600	....	....	....	....
Bethlehem	9,000	....	....	....	....
Chambersburg	6,000	300	....	2	....
Clairton	4,000	2,650	....	....	50
Clearfield	1,800	1,900	....	....	10
Connelsville	4,734	408	....	....	....
Freeland	....	....	....	20	12
Easton	205	6,807	....	....	....
Ellwood City	8,000	314	....	....	11
Glassport	....	....	6,500	16	....
Greensburg	4,235	394	....	3	....
Harrisburg	19,538	....	....	....	....
Luzerne	....	543	....	2	....
Meadville	2,634	4,180	....	21	....
Middletown	500	....	....	....	....
Monongahela	1,785	....	....	....	....
Nanty-Glo	2,080	....	....	8	....
New Castle	6,505	198	....	....	....
Uniontown	10,500	....	....	....	....
Parkesburg	1,098	....	....	....	....
Rankin	....	....	6,000	90	6
Sewickley	2,000	703	....	....	....
Rhode Island					
Pawtucket	5,388	865	19,961	53	11
Providence	6,087	3,152	17,068	96	....
South Carolina					
Orangeburg	31,380	7,456	....	65	....
South Dakota					
Aberdeen	1,000	34,000	....	500	100
Sioux Falls	22,540	5,195	....	....	29
Watertown	102,475	26,600	....	102	5
Yankton	2,452	....	....	....	100
Tennessee					
Clarksville	3,000	2,000	3,500	....	....
Dyersburg	3,080	420	....	....	....
Murfreesboro	....	....	600	20	10

| | | |

NEWS OF THE SOCIETIES

CALENDAR

Aug. 19-26—AMERICAN INSTITUTE OF PARK EXECUTIVES. Annual convention, Minneapolis, Minn. Secretary, Emmett Griffin, Supt. of Parks, East St. Louis, Ill.

Aug. 22-25—INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS. Annual convention, New Bedford, Mass. Secretary, Clarence R. George, City Electrician, Houston, Tex.

Aug. 28-Sept. 2—NATIONAL SAFETY CONGRESS. Detroit, Mich.

Aug. 29-30-31—LEAGUE OF CITIES OF THE THIRD CLASS IN PENNSYLVANIA. Annual convention, Williamsport, Pa. Fred H. Gates, Secretary, Wilkes-Barre, Pa.

Sept. 11-15—ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS. New Auditorium, Cleveland, Ohio.

Sept. 12-15—NEW ENGLAND WATER WORKS ASSOCIATION. 41st annual convention. New Bedford, Mass. Secretary, Frank J. Gifford, Tremont Temple, Boston, Mass.

Sept. 14-16—AMERICAN ASSOCIATION OF PORT AUTHORITIES. Convention at Toronto. Secretary, M. P. Fennell, Jr., Montreal.

Sept. 19-23—LEAGUE OF CALIFORNIA MUNICIPALITIES. Annual convention, Palo Alto, Cal. Executive secretary, W. J. Locke, Pacific Bldg., San Francisco.

Sept. 25-28—SOUTHWEST WATER WORKS ASSOCIATION. Annual convention, Hot Springs, Ark. Secretary, E. L. Fulkerson, Waco, Tex.

Oct. 2-6—AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS. Annual convention, Cleveland, Ohio. Secretary, Charles C. Brown, St. Petersburg, Fla.

Oct. 16-19 — AMERICAN PUBLIC HEALTH ASSOCIATION. Annual meeting, Chicago, Ill. Secretary, A. W. Hedrick, 370 Seventh Ave., New York, N. Y.

Nov. 15-16—NATIONAL INDUSTRIAL LEAGUE. Annual meeting, New York City. Secretary, J. H. Beck, Chicago.

Dec. 7-13—NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING. New York City.

WISCONSIN SECTION A. W. W. A.

A Wisconsin section of the American Water Works Association was formed on June 8 and 9, forty-eight or more being in attendance. The officers chosen were as follows: President, Prof. Daniel W. Mead; vice-president, Leon A. Smith; secretary-treasurer, C. M. Baker, sanitary engineer of the State Board of Health; all of Madison. The executive committee is composed of the officers and, in addition, H. H. Grifey, of Janesville, and H. P. Bohman, of Milwaukee.

TECHNICAL SOCIETIES PLAN PUBLIC WORKS BOARD

A plan for including a State Board of Public Works in the new constitution of the State of Missouri has been prepared by the Associate Engineering Societies, a Chapter of the American Institute of Architects, and the contractors, all of the city of St. Louis. This plan provides for directors of utilities, highways, waterways, and conservation, and their president to be appointed by the Governor of the State and to have supervision of the activities of five divisions.

Division of Structures will include land, natural resources, structures, equipment and improvements in which the State is interested.

Division of Utilities includes maintenance, equipment, operation and service of all public utilities owned or operated by the State and the assessment of rates and charges therefor.

Division of Highways includes construction, reconstruction, maintenance and inspection of all public highways and bridges for which State funds are used.

Division of Waterways will include waterways, water sheds, navigation, stream pollution, fisheries, water works, irrigation projects, plant control, water for development, drainage, and sanitary matters.

Division of Conservation will deal with the conservation of resources and State planning.

AFFILIATED TECHNICAL SOCIETIES OF BOSTON

"The Affiliated Technical Societies of Boston" was granted a charter on June 12, 1922, with the following nine societies as member organizations: Boston Society of Civil Engineers, New England Water Works Association, Plant Engineers' Club, Boston Sections of American Institute of Electrical Engineers and of the Society of Mechanical Engineers, and of the American Institute of Mining and Metallurgical Engineers, Northeastern Section of the American Society of Civil Engineers, Massachusetts Chapter of the American Institute of Heating and Ventilating Engineers, and Boston Chapter of the American Association of Engineers.

The council is composed of two representatives from each affiliated organization. It has elected as its officers: Leonard Metcalf as chairman, Alfred S. Kellogg and Alexander Macomber as vice-chairmen, Charles L. Hammond as treasurer, W. G. Starkweather as clerk and J. B. Babcock as executive secretary. The members of the executive committee are Messrs. Kellogg, Macomber and Frank A. Marston, together with the president and treasurer ex-officio. Among the committees arranged for are those on publicity, program, public affairs and legislation, employment and welfare, and library.

The Affiliated Societies will use the quarters of the Boston Society of Civil Engineers, and took these over as of date of June 1, having arranged with that society for the use of its quarters, library and equipment, and a similar agreement has been made with the New England Water Works Association, whose quarters adjoin those of the Boston Society, both located in Tremont Temple, Boston. The facilities include a technical library, current engineering periodicals, rooms for committee meetings and an assembly room fitted with stereopticon.

The objects and functions of the Affiliated Societies are stated as follows:

OBJECTS AND FUNCTIONS OF THE AFFILIATION

Objects

(a) Concentration of a united membership on questions of engineering interest, of importance to the Nation, State, City or to the engineers.

(b) Correlation of local group activities, — sometimes disconnected, sometimes overlapping, and at times even interfering,—and elimination of duplication of meetings and of effort.

(c) Improvement of the standing of technically trained men.

(d) Promotion of acquaintance, furtherance of better technical activity and increased esprit de corps among members of the organization.

(e) Maintenance of headquarters for resident and non-resident technical men, with facilities for meeting and correspondence, with a reference library, and employment clearing bureau.

(f) Maintenance of adequate facilities for society or group meetings, with the necessary plant and apparatus for the proper presentation and discussion of technical and related subjects.

(g) The possible issue at some future time of a joint publication of professional papers of interest to the members of the affiliated organizations.

(h) Possible co-operation in the future with some club for the enjoyment of its facilities at times of meeting of the Affiliation, affiliated organizations or committees thereof.

Functions

(a) The keeping of general records, and membership lists of all affiliated organizations.

(b) The co-ordination of meetings and programs, and the preparation for joint meetings.

(c) The preparation, publication and distribution of a periodic bulletin with notices of the meetings of the affiliated organizations; information of general interest; current legislative matters; committee reports or abstracts thereof and other society matters approved by the Council.

(d) Co-operation with the secretaries of the affiliated societies and furnishing secretarial and other assistance to them as far as possible in sending out special notices (not published in the bulletin); bills for membership dues; subscriptions, etc.; reports of committees, ballots, typewriting and other service of like character that may be required in the conduct of the affairs of the several societies. This work shall be done through and under the direction of the Executive Secretary. The officials of the affiliated societies shall have no authority over the office assistants or staff.

(e) The clerical work incident to the collection of dues from the affiliated societies. If the Executive Secretary is asked to and shall assist the secretaries of any of the affiliated organizations in collecting dues from their members, he shall assume no responsibility for the assessment, payment and collection of these dues other than for an accurate accounting of receipts.

(f) The maintenance of a technical employment bureau.

(g) The making of library researches at the cost of the members desiring them.

(h) Keeping in touch with like affiliations and groups of engineering societies and with American Engineering Council.

(i) Listing separately in the telephone directory the names of all of the affiliated organizations.

(j) Maintaining and developing if it shall prove practicable and advantageous a special service at a nominal charge, covering cost at least, for individual members of the affiliated organizations, under which they may receive mail, telephone and limited secretarial service at the quarters of the Affiliation.

All of these functions are to be carried out through the office of the Executive Secretary, under direction of the Council and the Executive Committee.

This is an affiliation merely, each of the societies retaining its individuality, holding its own meetings, etc., but having at its service the machinery for united action and also the facilities for "promotion of acquaintance, furtherance of better technical activity and increased esprit de corps"; the purpose being announced by the by-laws to be "bringing technical societies and their members into close touch with one another for more effective public service, and for the advancement of scientific investigation, education and research." Like its national prototype, the Federated American Engineering Societies, it maintains a bureau for bringing togther engineers of all kinds and those who desire their services.

PERSONALS

Brown, Major Cary H., assistant engineer commissioner of the District of Columbia, will shortly be relieved of that duty and assigned to duty at the engineer school at Camp Humphreys, Va.

Weisiger, L. M., field engineer of the South Carolina State Highway Department, has resigned to accept a position with J. M. Gregory of Newton, N. C. E. D. Sloan has been appointed to succeed Mr. Weisiger.

Patterson, Charles A., borough engineer of Torrington, Conn., has resigned. He will be chief engineer of the contracting firm of Mascetti & Holley of Torrington.

Swain, Clayton E., superintendent of public works, Rockville, Conn., has resigned, and is now associated with the U. S. Bureau of Public Roads.

Kelley, Robert E., of Willimantic, Conn., has been appointed an engineer of bridge construction for the Maine State Highway Department.

King, Edwin J., for five years county engineer of Sabette Co., Kansas, has been appointed Kansas representative of the Portland Cement Association to succeed Frank Altman.

Stephenson, Edwin J., until recently employed as construction engineer by the United Light and Railway Cos., Davenport, Iowa, has been appointed chief engineer of public construction for the city of Davenport.

Brigham, John C., has been reappointed city engineer of Summit, N. J., for a term of three years.

Seventon, H. L., has resigned as assistant engineer with the California State Highway Commission and will be employed as engineer with the Western State Power & Electric Co.

Fuetter, Otto, has been appointed city engineer and street superintendent of Venice, Cal.

Vogel, John Leonard, has been appointed bridge engineer of the New Jersey State Highway Department. He was formerly designing bridge engineer of the New Jersey Public Utility Commission.

Wanzer, J. O., has been appointed city manager of Marysville, Cal. He was formerly with the California State Highway Commissioner.

Farrier, Benj. E., has been appointed successor to John Ferris as member of the New Jersey State Highway Commission. Mr. Farrier is a plumber of Jersey City.

Dixon, G. Gale, has resigned as chief engineer of the Water Department, of Akron, O., which position he had held for five years. He will engage in business in Cleveland.

Connell, William H., has been selected by the Pennsylvania Committee on State Finances to investigate the State Highway Department. He will select a committee of highway engineers to aid him. His headquarters will be 912 Real Estate Trust Building, Philadelphia.

Shoecraft, Ezra C., for nine years city engineer of Flint, Mich., on August 1 became a member of the firm of Hoad, Decker and Drury, of Arbor, Mich., the firm name becoming Hoad, Decker, Shoecraft and Drury.

Powers, Cornelius Van Vorst, chief on one of the bureaus of the New York Transit Commission and former division engineer of the commission, died in New York City, June 18, aged 62 years.

Fitzgerald, Harrison W., engineer, has been elected Mayor of the town of Hamburgh, New York.

Tuttle, Arthur S., has been appointed chief of the staff of engineers to prepare plans for the Brooklyn-Richmond freight and passenger tunnel.

Smith, H. H., has been appointed deputy chief engineer on the staff abovementioned.

Coe, D. W., has been appointed resident engineer,

Shea, Wm. J., has been appointed assistant engineer.

Phipps, Francis H., has been appointed assistant engineer, and

Conant, Wm. M., has been appointed statistician of the above tunnel staff.

Dixon, G. Gale, formerly chief engineer of the Bureau of Water Works Improvement of Akron, O., has become associated with Frank A. Barbour, consulting civil and sanitary engineer of Boston, the firm name being Barbour & Dixon.

PAMPHLET NOTES

The 1922 edition of the "List of Publications of the Department of Commerce Available for Distribution" contains the name, date of publication, number of pages, and cost (when not furnished free) of more than two thousand pamphlets, reports and other publications of the Bureau of the Census, Coast and Geodetic Survey, Bureau of Fisheries, Bureau of Foreign and Domestic Commerce, Bureau of Lighthouses, Bureau of Navigation, Bureau of Standards, and Steamboat Inspection Service. The publications of the first two and some of those of the Bureau of Standards contain matter of interest to public works engineers. 88 pages. This list can be obtained by addressing "Chief, Division of Publications," Department of Commerce, Washington, D. C.

"Flexible Strength of Plain Concrete." By Duff A. Abrams, Professor in charge of Structural Materials Research Laboratory, Lewis Institute, Chicago. Bulletin No. 11 of the Laboratory, published June, 1922.

Result of testing 750 beams, giving details of tests and conclusions, one of which is that, for the usual concrete mixtures the modulus of rupture is about 22% of the compressive strength. The effect on flectural strength of various modifications of the concrete mixture are described. 25 pages. Apply to the laboratory.

"Proposed Zoning Ordinance for Akron, Ohio." As recommended by the City Planning Commission and City Planning Committee of Council. 18 pages. Also 3-page "Report of the City Planning Commission" of June 20, 1922.

"Mosquitoes and Mosquito Control," by Geo. W. Simons, Jr., Chief Sanitary Engineer, State Board of Health of Florida, and Geo. F. Moznette, Entomologist, Bureau of Entomology, U. S. Dept. of Agriculture. Published by the Florida State Board of Health. A discussion of the economic importance of mosquitoes in Florida, their habits, and how they can be controlled—36 pages.

Fire Fighting Facilities. Reports of National Board of Fire Underwriters on the water supply, fire department, structural conditions and hazards of Pasadena and Riverside, Calif., Philadelphia, Pa., and Cicero, Ill., being reports Nos. 329 to 332, published July, 1922.

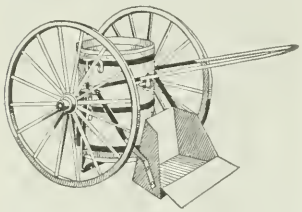
"Water Supply Needs and Resources of the Commonwealth" of Massachusetts. A report of the joint board of the State Department of Public Health and the Metropolitan District Commission. A book of 284 pages and several large folded maps and other inserts; dealing with the water supply requirements, adequacy of the present sources of supply, and new sources of supply; proposed works and their cost, and conclusions as to metropolitan district supply, including 16 cities and towns within ten miles of the State House and 9 outside this limit.

New Appliances

Describing New Machinery, Apparatus, Materials and Methods and Recent Interesting Installations

IRON HORSE STREET CLEANERS & SNOW SHOVELS

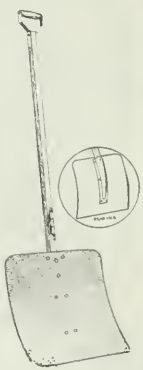
The Rochester Can Company, manufacturers of metalware, under the trade name of "Iron Horse," have placed on the market the type of street cleaner shown in the accompanying illustration. This consists of an iron street can carried in a frame of Bessemer steel equipped with an exceptionally good grade of 36-inch Sarvin wheels. The equipment shown is provided with a dust



"IRON HORSE" STREET CLEANER

pan attachment (it can be omitted when desired), which is attached by steel rods directly to the curved handle of the cart, in such a way that dirt swept into the pan can be dumped into the can by simply swinging the handle upward and over. The can is made of extra heavy gauge iron, reinforced top and bottom with a heavier iron band equipped with large heavy side handles.

The "Iron Horse" snow shovels are probably the most substantial made, using heavy galvanized iron wire around the outer edge and corrugated vertically, and further strengthened by three heavy steel rib enforcements riveted to the back, one of which receives the end of the handle. The point of the shovel is reinforced with a strip of steel riveted in place. The handles are made of straight grained hard wood and equipped with a wood grip. For heavy street work these are made in two sizes, one 17 inches wide at the bottom, 14 inches at the top and 14 inches high; the other 20 inches wide at the bottom, 16 inches at the top and 16 inches high.



"IRON HORSE" SNOW SHOVEL

"TALKING LAMP" FOR HIGHWAY

After experiments extending over a period of about six years, Foster Milliken, president of McNab & Harlin Mfg. Co., has evolved the Milliken Electric Street Signal "Talking Lamp" which is used for either danger spots on highways or for highway traffic control. Up to this time all traffic regulating lights have depended on simple color schemes to give police regulations either by day or night. This method of control is not only unsatisfactory but unsafe, as the majority of people do not even know what the colors mean or they fail to interpret them quickly enough to avoid danger, which, owing to the fact that the Milliken Lamp gives positive instructions by means of lettering that can be easily read and understood, has been aptly termed a "Talking Lamp."

The ideas in designing this lamp were: First, to use flashing colored lights that can easily be seen at a distance of a mile or more. Second, to give full information concerning police regulations and information relative to the location or direction to the traveling public. The third object was to have all of this information directly in front of the driver so that he would not be compelled to look other than straight ahead,

ELECTRICAL CONTROL FIXTURES FOR LAMP SHOWN ABOVE

REMOTE MULTIPLE UNIT CONTROL At 86th St. and Broadway New York

and further to have all of this information clear and distinct, not only in the day time, but particularly at night. The automobilists will without thinking naturally slow down to read the lamp and thus approach the danger spot at a reduced speed which is in the interest of safety.

The design of this lamp is particularly ornamental and pleasing in appearance. The lamp is divded into three separate and distinct horizontal compartments. The upper compartments contains a fixed white light and the letterings on the glass faces are intended to give the necessary police instructions. The center compartment contains the flashing electric lights placed behind the lenses. The lenses in the center compartment may be of any color to conform to any government, state, city or municipal regulation. The lenses used in the flashing compartment of the lamp are of special construction and are exceedingly powerful so that the light will penetrate fog and mist where ordinary lights fail. The idea of having two lenses instead of a single lens is to make the lamp unique so that it cannot be confused with any other lights.

The lower compartment of the lamp contains a fixed white light, and the lettering on the glass face is generally intended to give the location or information relative to direction of principal cities or towns.

PUBLIC WORKS.

CITY COUNTY STATE

A Combination of "MUNICIPAL JOURNAL" and "CONTRACTING"

Vol. 53 September, 1922 No. 7

Constructing Scituate Reservoir

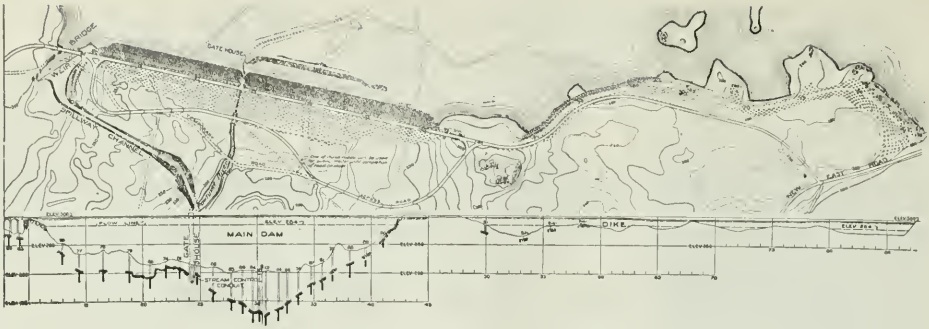
Construction of a dam and dike nearly one and a third miles in combined length to furnish improved water supply for Providence, R. I. Contractor's modernly equipped camp. Steamshovel work, complicated by quicksand and boulders. Traveling cableway for deepest excavation.

The water supply for the City of Providence, Rhode Island, which since December 1, 1871, has been taken from the Pawtuxet River at a point ten feet above mean high tide, requires an amount considerably greater than the normal dry weather flow of that stream. Moreover, the stream here is highly polluted and for some years the water has been filtered. In order to obtain a less polluted water, abundant storage and a gravity supply, the Scituate Reservoir is being built. It will be formed by the construction of an earth dam and dike across the valley of the north branch of the Pawtuxet River, two miles north of Hope, R. I., and about 10 miles from the City Hall of Providence.

GENERAL DESCRIPTION

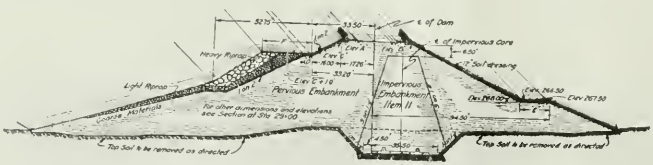
The reservoir will have a capacity of about 36,900,000,000 gallons. It will deliver water by gravity to an elevation at least 50 feet higher than that of the present distributing reservoir, or 232 feet above tide water. A new filter plant will be built and a seven-mile aqueduct which will have a capacity of 85,000,000 gallons daily (nearly four times the average consumption in 1921) will connect with the existing pipe system of the city.

CORE TRENCH, SHOWING ROCK SURFACE, CONCRETE BLANKET AND CUT-OFF WALLS AND STARTING OF IMPERVIOUS CORE.



PLAN AND PROFILE OF MAIN DAM AND DIKE. CORE BORINGS INTO ROCK AND SURFACE OF ROCK SHOWN ON PROFILE OF DAM.

The new reservoir will have a drainage area of 92.8 square miles, a water surface of 3,600 acres, an average depth of water of 32 feet, a flow line elevation 284 feet above high water in Providence Harbor, and a length of flow line of 38 miles. It will involve the construction of 26 miles of new highways and the abandonment of 34.7 miles of old roads. It will contain 28 islands and will submerge a number of small cemetery sites, which contained about 1,480 graves the remains from which have been transferred to a new cemetery. In the condemned area there are 375 dwelling houses, 7 school houses, 6 churches, 6 cotton mills, and many other buildings.



SECTION OF DAM AT STA. 18 + 00.

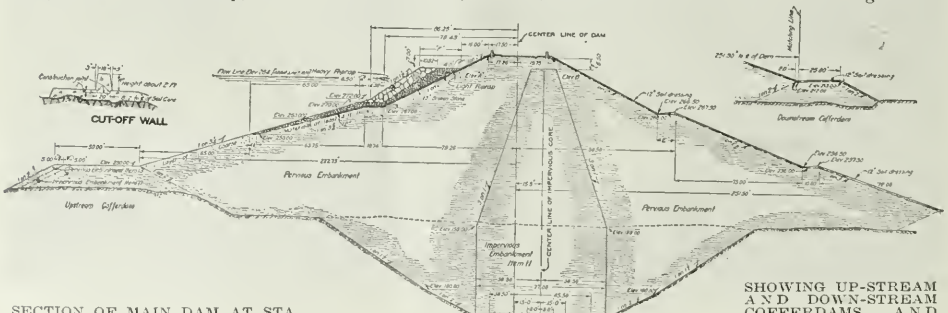
THE MAIN DAM

The main dam will be 3,200 feet long on top, 640 feet in maximum width at the base and 100 feet high above the valley, below which the foundation will be carried down to solid rock at a maximum depth of about 80 feet below the old stream bed. The thickness of the dam at flow line will be 118 feet; the width at the top, 13 feet above flow line, will be 37 feet. The cubical contents of the dam, including refilling below the surface of the ground, will be about 2,500,000 cubic yards. There will be a spillway with a clear length of 413 feet and a spillway channel to the river below the dam about 1,800 feet long.

THE DIKE

The dam will be supplemented by an earth dike about 4,000 feet long, 33 feet in maximum height and 15 feet in average height, which will be constructed substantially like the dam, and will contain about 200,000 cubic yards of material. The watertightness of the dam will be secured by a central core 77 feet in maximum thickness, composed of selected soil stripped from the reservoir basin and thoroughly compacted in 6-inch layers by heavy steam rollers. The upstream face of the dam will be protected against wave action by heavy riprap and the downstream face will be covered with top soil and grassed.

The work is being done under the direction of a Water Supply Board having seven members, of whom B. Thomas Potter is chairman. Samuel N. Grammont is secretary for the board, Frank E. Winsor is chief engineer, J. Waldo Smith is consulting engineer, William W. Peabody is deputy chief engineer in charge of Dam and Aqueduct Division, Frank E. Waterman is division engineer in



SECTION OF MAIN DAM AT STA. 29 + 00.

SHOWING UP-STREAM AND DOWN-STREAM COFFERDAMS AND CUT-OFF WALL.

charge of Reservoir Division, and Francis B. Marsh is designing engineer.

PRELIMINARY WORK

Up to July 1, 15 major and 5 minor contracts, ranging from about $610 to $3,500,000, had been awarded to different contractors for boring, stream control work, roads, regulating dam, bridges, dwelling and office, and for the construction of the main dam and dike and subsidiary works at Kent. The last named contract was awarded on May 12, 1921, to Winston & Company, Inc., for the sum of $3,499,925. About four and one-half years is allowed for the execution of this contract, which, according to contract requirements, must be completed in November, 1925. Work was commenced on May 21, 1921, and on August 10, 1922, about 27½ per cent of the estimated total value of the work had been performed.

A diversion channel for the Pawtuxet River, to detour the flow around the site of the deep excavation, was constructed under previous contracts. This consists of a canal about 600 feet long, about 30 feet wide at water level, with a depth of water of about 5 feet, delivering to a horse-shoe type of concrete conduit 21 feet 4 inches high and 25 feet wide, inside dimensions, and about 500 feet long. It was necessary to line the canal with concrete for its entire length on account of the extreme permeability of the soil, which was demonstrated later by the fact that when the water rose above this lining, it seeped through the earth into the main excavation, a distance of from 200 to 700 feet, considerably augmenting the normal seepage.

The contractor started, in June, 1921, the construction of a standard gauge spur line about two miles long to connect the dam site with the New York, New Haven & Hartford Railroad at Jackson, R. I. This involved about 50,000 yards of grading, mostly earth, and the construction of a trestle bridge 500 feet long across the Pawtuxet River. Over this spur has been delivered all the heavy plant and most of the supplies required.

The railroad was completed in about three months and has been equipped with a 54-ton 6-wheel locomotive, seven 34-foot flat cars and one 12-foot flat car.

EMPLOYEES' CAMP

The location of the contractor's camp is downstream from the dam in a broad, rolling field of fairly high elevation overlying sand and gravel strata, affording excellent drainage. The houses have 3, 4 and 5 rooms, are built of wood and covered with building paper. The camp is laid out in streets radiating from the office building, which occupies a prominent elevation from which every house and street in the camp can be viewed. The camp is divided into sections for the foremen, resident families, Negroes, Italians and other nationalities. Many of the Italian families keep boarders.

The census of the camp taken July 1, 1922, showed:

	White	Colored	Total
Males	197	35	232
Females	42	0	42
Children	52	0	52
	291	35	326

In addition to these, there are 109 white males

EXCAVATING DEEPEST PART OF CORE TRENCH, SHOWING CONSTRUCTION TRACK SYSTEM WITH SWITCHBACKS.

DELIVERING SAND AND GRAVEL BY TRAIN INTO COFFERDADM.

who work on the job but who live in the nearby towns.

The camp sanitation is taken care of by the installation of the Kaustine system, by which the sewage is treated chemically in large iron tanks by a solution of caustic soda. The drainage from sinks and wash water runs directly into cesspools excavated in the gravel or sand.

The commissary is centrally located, near the office building, and is prepared to furnish the employees everything in the way of groceries, provisions, meats, house furnishings, clothing, etc. The employees patronize this store at their own volition, as they are under no obligation to trade there if they do not so desire.

The camp is electrically lighted, there being street lights located on poles in the different areas. Most of the houses are electrically illumined. Electricity is paid for by the users, but the company furnishes fuel (coal and wood) throughout the camp, which is included in the rent paid for the cottages.

There is a modern and completely equipped hospital located in the camp area, containing one ward with four beds, one with two beds, a "pest" room, kitchenette for the preparation of diets, an operating room, nurses' living quarters, and general office and waiting room. This hospital is prepared to handle at any time any case that is brought to it for attention, as there is a resident camp physician and surgeon and a graduate nurse available at all hours of the day and night. To partially cover the cost of this department, the employees pay the nominal fee of 25 cents each per week.

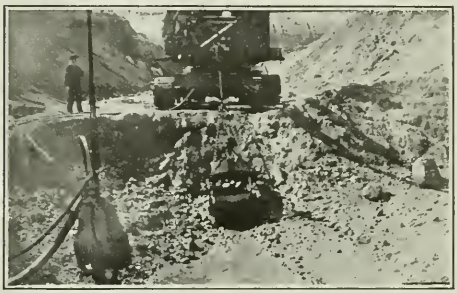
The camp is equipped with a laundry, a barber shop, tailor shop, and shoemaker's shop. All the buildings are located at a distance from each other sufficient to reduce the fire hazard to a minimum, and in addition to this precaution there are water line and fire hydrants so located that it is possible to run at least two lines of hose, not over 500 feet long, to any point in the area. This water line is provided with a direct connection to a large supply tank, and in case of fire the domestic supply tank is by-passed and the water has a good pressure derived from the larger tank.

Ice is furnished to the employees living in the camp from three ice houses stocked with ice cut by the company on a lake in the reservoir basin.

Supplies for the camp commissary and boarding houses are secured by a company truck which goes to Providence every day, a distance of about 15 miles. A large part of the small materials and supplies for the work are secured in the same manner, thereby reducing the amount of parts and supplies that it is necessary to keep on hand in the storehouse.

COFFERDAMS

Before beginning work on the dam itself, cofferdams were built both above and below the dam site, the latter being necessitated by the backwater from the mills lower down. These cofferdams are small earth embankments containing about 120,000 yards which was taken from the first material excavated from the dam



DRAGLINE EXCAVATING SUMP.

foundation, and was so selected and placed as to form an acceptable, integral part of the finished dam. The up-stream cofferdam is 50 feet wide on top, the down-stream cofferdam is 25 feet wide on top, and the respective maximum heights are 35 and 15 feet, with slopes of 2:1 on the outside. The loam was stripped from the surface of the ground before building the cofferdam.

PRINCIPAL OPERATIONS

On July 25, 1921, a No. 20 Marion steam shovel commenced excavation for the soil core and on August 5 a second No. 20 Marion steam shovel was installed on the same work. On September 13 a No. 70 Bucyrus steam shovel was installed and on October 17 a second of the same make and size. Stripping of the top soil of the spillway channel was commenced October 31 by a steam shovel, the soil being placed in a storage pile for use in the core construction.

During 1921 there was an average force of 247 men and up to December 17 the principal items accomplished, amounting to about $380,000, were clearing 55.4 acres; grubbing 2.3 acres; removing 22,600 cubic yards of soil; excavation above elevation 195, 81,600 yards; between the elevations 195 and 160, 94,600 yards of earth and 4,400 yards of rock; impervious embankment, 6,260 cubic yards; pervious embankment above elevation 195, 152,500 cubic yards.

EXCAVATING FOR DAM

The main dam and dike construction is essentially a steam shovel job. The excavation of the pit was a serious hazard for most of the competitive bidders, the soil being sand and gravel with large patches of quicksand and heavy de-

posits of large boulders. A maximum depth of excavation of 80 feet to the very irregular surface of granite gneiss formation was required A careful preliminary study of the situation convinced the contractor that the key to the problem lay in the proper sequence and methods of excavation, which eventually developed into a system of flank encroachments on the earth. At first it was proposed to provide preliminary drainage through a progressive series of deep sumps, but the nature of the ground was such that the water did not flow freely in all cases, and the plan was rendered especially difficult by the quicksand beds, of great volume and up to 50 feet in depth.

Early in the operations, a sump was sheeted down to a depth of 25 feet, encountering a large quicksand deposit which gave considerable trouble. A pipe was sunk 10 feet and when it was pulled out, the water followed and boiled out of the hole. Efforts were made for a few days to sink this sump, but the boiling of the quicksand nearly to the top of the pit convinced the contractor that the plan was not feasible, and thereafter the main drainage was effected by the steam shovel cuts themselves, working to a drainage grade.

Two 70-ton Bucyrus shovels were installed, beginning at the west end of the pit, the extreme surface dimensions of which were about 1,000 feet east and west and 130 to 300 feet north and south. The shovels began at the extreme outer edge, working down to their normal lift of 11 feet and proceeding upon opposite sides of the pit, approximately parallel to the longitudinal axis. They moved at a very slight up-grade sufficient to provide drainage back to the starting point, which was effected through a narrow ditch, 3 to 4 feet wide, shoveled out by hand at one side of the cut. Arriving at the end of the pit, the shovel was moved back to the starting point and made another cut alongside, and so on, until the two shovels met in the center of the pit; after which an outside cut was again carried down to a new lower working level and the operations repeated many times until the excavation was completed.

Excavated material was loaded by the shovels into 4-yard dump cars on a 36-inch gauge service track and hauled out of the pit on a causeway having a grade eventually varying from 4 to 8 per cent maximum. Most of this material was placed in the permanent embankments. The total excavation amounted to about 350,000 yards, of which as much as 10,000 yards was boulders of a half-yard or more, one having been encountered that measured 63 cubic yards. All of these boulders were paid for as rock excavation under the terms of the contract. When the quicksand was encountered, the shovels were able to work over it on a bridge of slabs from the contractor's sawmill. The slopes through the quicksand gave some trouble but were controlled by careful operation and a liberal use of gravel and boulder blankets to hold the face.

After the grade of the service track became too steep for profitable operation, the small remainder of the material excavated from the pit and the cleanings of the rock surface were handled

CORE TRENCH, JUNE 1, 1922. STREAM CONTROL CONDUIT AT LEFT BACKGROUND. UP-STREAM COFFERDAM AT THE RIGHT.

in 4-yard skips operated by an 800-foot Lidgerwood traveling cableway, moving on tracks 500 feet long parallel to the axis of the dam. This provided for the very convenient handling of rock, pumping plant, etc., and was found to be adequate, although provision had been made for two cableways. The cableway and the train service suffice for handling most of the material and are supplemented at present by three guyed derricks: one in the pit, one adjacent to it and one in the screening pit—all equipped with 7 x 10-inch American Hoist and Derrick Company's hoisting engines.

The drainage from the shovel cuts was led to a series of open sumps, five in all, only two or three of which were operated simultaneously. These sumps were most advantageously made by the use of two Bucyrus 30-B crawler traction draglines, which opened pits usually 40 to 50 feet in diameter and 10 or 12 feet in depth, the bucket working satisfactorily to the bottom of the pit under the surface of the water. When not engaged in sump work, the draglines were found extremely convenient for cleaning up after the shovels, for shifting the service track in unbroken lengths from one shovel to the other, and for various other services which they could perform with their 40-foot booms equipped with ¾-yard Page buckets.

These draglines excavated with an efficiency probably 60 per cent that of a steam shovel with the same size bucket. When used on straight excavation, they handled about 600 yards in 10 hours each. Under the difficult conditions encountered, each 70-ton shovel handled about 1,000 yards per day of 10 hours, and the monthly excavation in the big pit varied from 20,000 to 37,000 yards. Of course, on short cuts, considerable time was consumed in moving the shovels back and in changing the grade and track.

There was a large flow of clear, cold water into the excavation, which increased gradually with the depth and was intercepted at the various sumps and removed from them by the use of six No. 6 D. S. Volute Cameron centrifugal pumps with 8-inch suction, 6-inch discharge and a maximum lift of 90 feet. These pumps were operated by electricity purchased from the Narragansett Electric Lighting Company. A small steam pump, located in the pit, delivered a large flow of pure, cold water running out of the gravel strata, through a 4-inch pipe under 120 foot head to a stand pipe of 13,000 gallons capacity, which furnished water for the camp. The supply for the boilers and mechanical purposes was pumped direct from the river by a No. 6 D. S. Volute centrifugal pump, electrically driven, which delivered against a head of 150 feet to a 50,000 gallon wood tank which supplied the work through two 6-inch lines, one on each side of the dam. The average amount of water pumped from the pit amounted to about 4,000,000 gallons daily.

DRESSING AND GROUTING BOTTOM

After the irregular rock bottom in the pit had been exposed, it was cleaned up by hand, carefully washed down, barred and wedged to remove loose or decayed rock, and the open seams and big pockets were filled with concrete. A double row of staggered grout holes about 20 feet deep were drilled for the entire length of the dam. These holes started at 2⅝ inches, were reduced in 2-foot sections to 1⅞ inches at the bottom, and were made with Ingersoll-Rand No. 3¼ and No. 4 drills, operated by steam.

The rock was so hard that it was necessary in extreme cases to use as many as eight steels in each 2-foot section, and the average time for making a 20-foot hole was about 10 hours. Two-inch pipes were caulked into these holes and the projecting tops capped, to serve later on for grouting under 10 to 20 pounds pressure, which it is believed will thoroughly close the numerous seams in the rock. After the principal irregularities of the bottom had been concreted, low cut-off or core walls of concrete were built on the surface parallel to the axis of the dam. They were not more than 3 feet high and about 18 inches wide, serving chiefly to intercept any continuous flow of water through the earth embankment that might tend to occur.

EMBANKMENT

The main dam contains a core of soil rolled in 6-inch layers estimated to contain about 600,000 yards of selected top soil and subsoil, stripped from the reservoir basin. The remaining 2,000,000 yards in this embankment is of miscellaneous materials, including sand, gravel and boulders, wet down. The large amount of core material of special quality is stripped by steam shovel from 300 acres or more of the reservoir area, selected as near as possible to the dam. These shovels, all of which have crawler tractions, move freely over the irregular surface and excavate to a depth of from 8 to 36 inches, delivering at first to a spoil bank adjacent to the track system.

Outside of casting distance, the shovels deliver to bottom-dump 2-yard Eagle wagons which are hauled a distance of 200 or 300 feet by mule teams and build the spoil banks to an average height of 10 feet. These banks are generally located in pairs, with a 36-inch gauge track between them, providing for the loading of the soil by a steam shovel to trains that will convey the soil to the dam when building the core. Although this method involves double handling of the earth, it is so simple and so completely avoids delay, that it is considered satisfactory and economical. The material for the outer part of the embankment will be excavated by steam shovels in borrow pits and delivered directly to the embankment. No stripping of the reservoir will be done beyond that necessary to secure material for the soil core.

CHANNEL, SPILLWAY AND BRIDGE

The spillway channel, about 1,800 feet long and 30 feet wide at the bottom, involves an excavation of about 125,000 yards of earth and 20,000 yards of rock. The maximum depth of the cut is 30 feet, which will be generally steam shovel work with some blasting. Channel excavation will be carried on only as the material

can be simultaneously placed in the embankment, thus avoiding rehandling.

The spillway is a concrete structure 413 feet in clear length, about 18 feet high at maximum section and is founded partly on solid rock and partly on earth. From it a channel 1,800 feet long will carry the water back into the Pawtuxet river.

Another principal unit of construction is the highway bridge across a small arm of the reservoir at the spillway. This consists of three reinforced concrete arches, the end arches having a 55-ft. span and the center one a 50-ft. span. The centering consists of timber falsework resting on mud sills. The bridge is being built under a sub-contract by the Briggs Engineering & Construction Company of Providence.

PLANT

The contractors have installed a large and costly plant for the execution of the work with rapidity and efficiency. It includes 2.35 miles of standard gauge track, 15,000 feet of narrow gauge, 10 steam shovels, 4 steam rollers, 6 electric centrifugal pumps, 12 steam pumps, 2 boilers, 10 gasoline and hand pumps, 12 drills, 4 derricks, 5 automobiles, 2 cableways, 2 concrete mixers, 1 grouting machine, a saw mill, air compressor, and miscellaneous equipment. The teams equipment includes 87 mules, 30 dump wagons, 11 dump carts, 3 road wagons, 6 wheel scrapers, stone boats, water wagons, etc. Also 2 riding horses. There is a blacksmith shop for shoeing the stock and repairing wagons, and a machine and repair shop very completely equipped. The machine shop has been found of great service in that it almost wholly eliminates delays for the repair and maintenance of the plant, and with a small amount of spare parts kept in stock, insures the continuous service of steam shovels and other equipment.

The coal bin is quite an important feature. The coal is delivered over the standard-gauge spur track in bottom-dump hopper cars direct to the dumping trestle, which is 30 feet above the ground, where the coal is dumped into bins.

All machinery is operated by steam except the electric pumps, the saw mill and the machine shop. There is also a small portable air compressor plant to operate pneumatic tools and drills. The saw mill has a capacity of 10,000 feet b. m. per day, and has been occupied in sawing up timber cut on the reservoir site, producing rough timber for construction, standard and narrow-gauge ties, rough boards, etc., thus reducing materially the large cost of lumber for the camp and other purposes.

Sand and gravel for concrete are brought in wagons and are handled by a derrick and clam-shell bucket to a gravity screen, which separates the sand, gravel and large boulders, delivering directly into 4-yard dump cars on a 36-inch gauge track.

The present force numbers about 340 men, of whom the average number in the large pit is about 15 or 20, excluding the concreting gang. M. J. Look is general manager for the contractor.

The Wanaque Reservoir

The Wanaque reservoir, as described in PUBLIC WORKS for August 27, 1921, is being constructed by the North Jersey Water Supply Commission to furnish a supply of water to Newark, N. J., and other municipalities in the northeastern part of that state. The contract on this work that has been progressing for several months past was for the core wall only of the dam, and that contract has now approached so near completion that Contractor Gahagan is withdrawing his equipment and notified the commission on August 24 that by the end of that month more than $11,000 worth of equipment would have been removed; the reason for this notification being that the contract is being done on the percentage basis, the commission paying a rental for the equipment used.

When the work was started it was proposed to construct a reservoir sufficient to guarantee a yield of 50,000,000 gallons per day. By raising the reservoir 24 feet higher, this quantity can be increased to 96,000,000 gallons, plus 12,000,000 gallons per day which must be allowed to overflow into the river daily to protect the riparian rights of the land owners lower down.

The increase in capacity is being considered because of the probability that 39,000,000 gallons per day will be taken by the three cities of Paterson, Passaic and Clifton. Representatives of these cities last month came to a practical agreement with representatives of Newark, that the latter city would take the same amount, each with the privilege of selling to other communities such portion of its half as it might desire. It was also agreed that of the estimated cost of $16,000,000, the three smaller cities would pay $6,000,000, Newark would pay $7,000,000 because of the longer supply main required to reach that city, and the remaining $3,000,000 would be borne by other municipalities that may apply for a share in the 18,000,000 gallons remaining to be disposed of to other communities by the commission.

Of the total cost the engineers estimated that the reservoir, including gate house, dike, highway relocation, etc., would cost $10,120,000, and aqueduct (of concrete and steel pipe) would cost $5,880,000.

Other North Jersey communities are considering using the Wanaque supply, among these being Kearny, the town council of which a few weeks ago directed and empowered the Mayor and Water Committee to negotiate with the North Jersey Commission for 10,000,000 gallons daily.

Meantime the Lehigh Valley Railroad has won a chancery court suit to enjoin the development of the Wanaque watershed on the ground that the railroad, as lessee of the Morris Canal, would suffer serious injury because of diversion of water from the canal. It is said, however, that this decision of the chancery court will be appealed and that it will not result in any delay in the construction work.

Brownsville Avenue Reconstruction

By Albert N. Dick

Important thoroughfare re-aligned and re-graded, new retaining walls built and old ones strengthened. Roadway made ten feet wider on curves than on tangents. A quarter mile of 9.22 per cent. grade after-regrading

The many hills upon which Pittsburgh, Penn., is built are the chief cause of a number of difficult engineering problems that are continually presenting themselves to the Department of Public Works of that city. Along the south bank of the Monongahela River the hills rise in precipitous bluffs, upon the crests of which are located important residential sections interspersed with a number of small business centers. Stretching out for miles beyond this are a number of boroughs and townships which, though divided into numerous municipal corporations, form in effect one continuous city almost to the Allegheny county line.

A large part of this territory, familiarly called the "South Hills," lies immediately opposite the business section of the city, and the problem of accommodating the ever-increasing traffic between the South Hills and the city is one of growing difficulty. There are several streets leading from the South Hills to the business center, but Brownsville Avenue is probably the most important among them owing to its central location. Its lower or western terminus is about 600 feet east of the Smithfield Street bridge, and the eastern terminus, near the top of the hill, is in a section of the city known as Allentown, at Warrington Avenue which leads directly into West Liberty Boulevard, a fine new highway running to the boroughs of Dormont, Mt. Lebanon, Castle Shannon, etc. The Smithfield Street bridge, only a block from the western terminus of Brownsville Avenue, leads directly into the business section of the city. The importance of the avenue as a means of travel is therefore apparent.

BROWNSVILLE AVENUE, SHOWING OLD PAVEMENT, TRACKS AND SLIDE OF HILLSIDE.

Before the commencement of the present improvement, Brownsville Avenue was poorly paved, with a narrow roadway, steep grades, bad curves and acute angles. It fell 400 feet in a length of 6,000 feet, with a maximum grade of 10 per cent. and 21 angles. Stone walls were constructed along the greater portion of the slope or downhill side of the street to retain the fills, and at certain points there were retaining walls on the hill side to protect the street against slides. These old walls were constructed with a facing of quarry-face stone backed with rubble, all set in mortar. In a number of places they have bulged quite appreciatively from their original position.

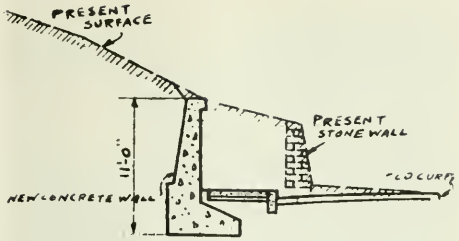
The original paving was cobblestone, which was laid 50 years ago. Some of this had later been removed and replaced with irregular block stone, and some with regular stone block paving.

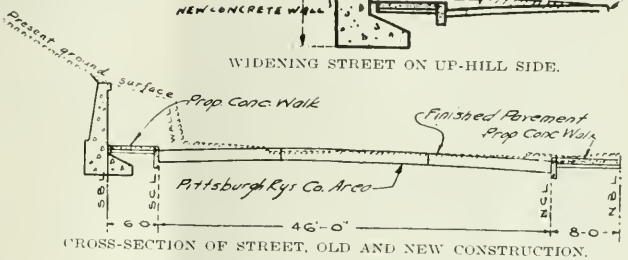
The abutting property was well built up on the slope side, and at intervals on the hill side also where the topography of the ground admitted of the erection of buildings.

Two lines of trolley tracks were laid some years ago on Brownsville Avenue by the Pittsburgh Railway Company, but on the completion

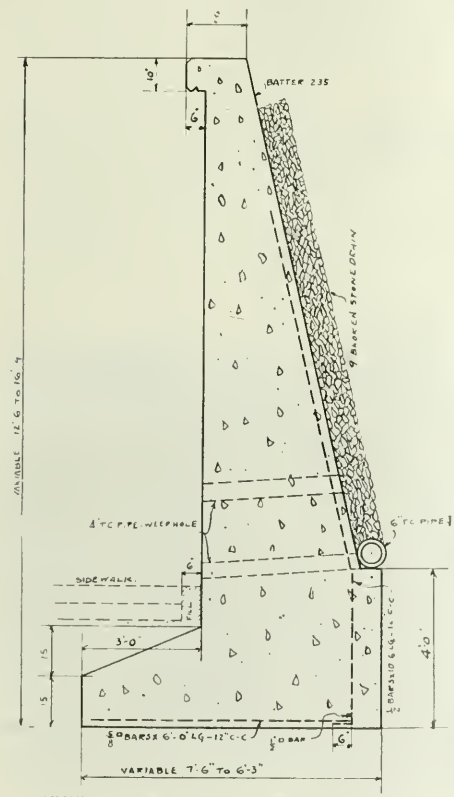
ABUTTING RESIDENCES AND OLD WALL.
Note cracks in wall.

of the tunnel under Mt. Washington all but one line of cars was diverted to this outlet. Owing to the steep grade of the street, derail switches were installed at several points, requiring cars to stop on reaching a switch until the men operating them had closed the derail switch to permit it to proceed. In spite of the presence of these tracks and switches and the bad condition of the pavement, traffic of all kinds and descriptions was quite heavy and the various civic bodies of the South Hills were continually making demands for the improvement of the avenue. The north end of the new Liberty tunnel is located not far from this street and it is expected that the traffic to the city through the tunnels will use Brownsville Avenue at the completion of the tunnel, until such time as the viaduct which will connect up the tunnel with the city shall have been completed.





Because of its increasing importance as a thoroughfare, it was decided to improve Brownsville Avenue and surveys were made, cross sections and contours were taken and a general engineering investigation made with a view to finding the most desirable location for the street conforming as far as practicable with the old lines yet eliminating some of the worst curves and angles, and giving a wider roadway.



There were many dwellings along the line of the street, most of which were occupied by their owners, and because of the acute shortage of houses in the city as well as of the cost, it was deemed necessary to keep the destruction of these houses at a minimum. After an exhaustive study of all the proposed lines, a location was finally decided upon and the necessary legislation enacted.

The preliminaries leading up to this point were very tedious and occupied a great deal of time. Ordinances were prepared and introduced in the City Council, a Board of Viewers appointed, public hearings held, and the whole proposition submitted to the courts for confirmation. With the last legal barrier removed, the city was ready to proceed with the physical work and the contract was let to Booth and Flinn, Ltd., of Pittsburgh, for the sum of $152,500. Work on this contract has not been completed at this writing, but practically all of the grading has been done and all the walls built and it is expected that the paving will be completed in a short time.

ALIGNMENT AND GRADE

Beginning at the hill top or eastern end of the street (although as a matter of fact it runs for a distance almost due east before turning into its general westward direction) the street has been widened from 50 feet to 60 feet with a 10-foot sidewalk on the slope side and a 6-foot walk on the hill side. About 1,100 feet from the starting point the line turns to the left by a series of curves, first compounding and then reversing to the right and the left, making four curves; the P. T. of the final curve being about 1,300 feet from the first P. C.

The curb lines of the terminal curves are nonconcentric but are so arranged as to widen both

street and roadway on the smaller radii curves, beginning at the first P. C. with a 36-foot roadway, widening this to 46 feet and reducing it again at the final P. C. to 36 feet. Some property was taken along the curves to permit of this widening, mostly from the hill side.

Walls were built along the hill side varying in height from 12 feet to 17 feet. At one point a small curtain wall was necessary on the slope side, this wall being built outside of an old stone wall that had been erected on the lines of the old street. Open-joint terracotta pipe, broken stone backing extending from the pipe to the top of the wall, and weep holes at the bottom of the wall, provided for drainage of all the retaining walls.

The grade over this part of the street began at 6 per cent., changed by vertical curve to 3.5 per cent. and then again by another vertical curve to 7.4 per cent.

Beyond the curve the line runs almost due west. At a point 2,650 feet from the beginning there is another series of curves, first to the left and then to the right and again to the left. Here again the roadway is widened, reaching 41 feet on the central curve and again reducing to 36 feet at the final P. T. Property was taken on this section of the street on the hill side which required the removal, razing or alteration of a number of houses. The grade over this section changed to 5.25 per cent.

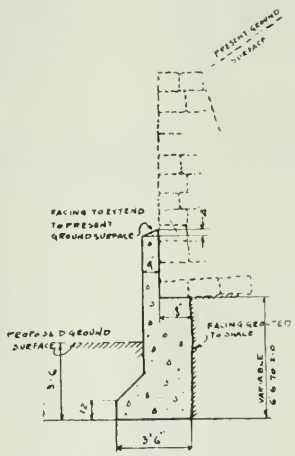
At about 4,200 feet from the beginning the grade changes to 9.22 per cent., at which it continues to the end of the street. The roadway on the final tangent is 34 feet wide, with 10-foot and 8-foot sidewalks on the slope side and hill side respectively.

CONSTRUCTION

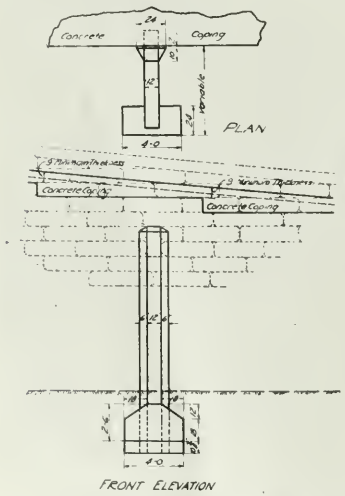
The retaining wall work was varied at different points to meet the different conditions. At one place an old stone wall was strengthened by building concrete buttresses and installing a concrete coping. At other points concrete walls, both plain and reinforced, were built; also one wall of cyclopean masonry, the stone used in this being taken from old stone walls. In the cyclopean masonry the contractor was required to lay the stones horizontal with at least 6 inches of concrete on all sides of each stone.

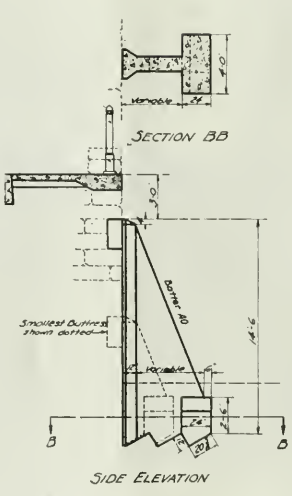
The pavement is ordinary Ligonier stone block set on an 8-inch concrete base, the joints filled with portland cement grout. The curbs are of concrete protected with 3 x 2 x 3/8-inch angles on the exposed edge and set in a trench on one foot of broken stone drain which is connected to catch basins.

One car track is left extending the entire length of the street and the pavement between the rails is of the same character as the balance of the road. The rails are 9-inch Trilby supported by wooden ties, the spaces between the ties being filled with concrete. All the work in connection with the track and for one foot outside of it is being done by and at the expense of the

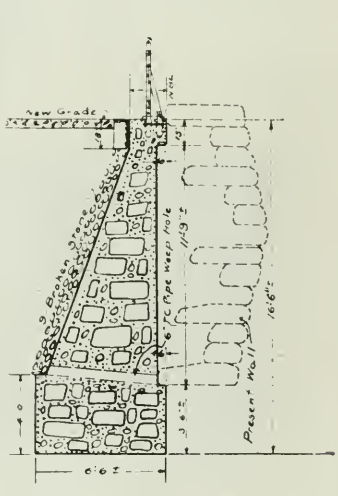


METHOD OF UNDERPINNING WALL





DETAILS OF BUTTRESS FOR OLD MASONRY WALL



REPLACING BULGED WALL

SECTION OF NEW WALL ON DOWN-HILL SIDE.

Pittsburgh Railway Company. The work was constantly under the supervision of the city and many tests were made of the materials entering into its construction.

Excavation was done by means of two No. 28 Marion shovels. The earth not needed for grading was removed by large motor trucks. The wall trenches were excavated by a steam auto crane using a half-yard clam-shell bucket, the same machine being used with a dump bucket for pouring the concrete into the forms.

The concrete was mixed in proportion of 1 cement, 2½ sand and 5 gravel. A Rex paver was used in mixing the concrete, chuting the concrete directly onto the finished subgrade for the pavement base, and into the curb forms for the curbs. No concrete was poured during freezing weather.

The contract called for the following items:

18,000 cu. yds. grading at	$0.90
1,050 cu. yds. trench excavation at	2.50
15,340 sq. yds. block stone on 8-in. founda. concrete	4.85
10,500 lin. ft. protected concrete curb	.90
171 lin. ft. protected concrete radius curb	1.60
300 sq. ft. granite crossing	1.25
54,000 sq. ft. concrete sidewalk	.20
28 catch basins	80.00
390 lin. ft. terra cotta pipe sewer	3.00
1,065 cu. yds. concrete in retaining walls	16.00
78 cu. yds. concrete in buttresses	20.00

and 14 other items.

The work was under the supervision of Charles A. Finley, Director of Public Works; Charles M. Reppert, Chief Engineer; Tom M. Reed and Samuel Eckles, Assistant Chief Engineers; and Antes M. Snyder, Construction Engineer.

Specifications for Pressure Water Filters

The associated manufacturers of water purification equipment has adopted certain standards for pressure water filters, these fixing the capacities of filter and construction details of both steel and cast iron pressure filters.

The rates of filtration should conform to the following schedule: Two gallons per square foot per minute for all supplies used for drinking or for the preparation of food products. Two to 4 gallons per square foot per minute when filtering a treated municipal supply of approved bacterial purity. Two to 4 gallons per square foot per minute for swimming pools and for all industrial uses.

Two to 5 gallons per square foot per minute as conditions may warrant for double filtration, using sand followed by charcoal where reduction of color, odor, taste or certain forms of iron is desired. This method of filtration not to be applied for bacterial purification.

A table is given showing the capacity of filters of different diameters from 1 foot up to 8 feet for the vertical filters and of 8 feet cylinders with lengths between 10 feet to 25 feet for the horizontal filters; also the size of pipe connection for filter wash and for waste to sewer and the amount of wash water required at 12 gallons per square foot per minute. The inlet outlet filter waste pipes for vertical filters range in size from ¾″ for a 12″ cylinder to 5″ for an 8 foot cylinder, while the sewer waste pipes vary from 1″ to 6″. The wash water varies from 9.42 gallons to 600 gallons. The horizontal filters, which have larger capacities, have filtered wash pipes of 6″ to 8″ diameter and waste pipes of 8″ to 10″, while the wash water varies from a minimum of 822 gallons for a 10 foot filter to 2,157 gallons for a 25 foot filter.

The filter shells are calculated for working pressures of 65 lbs., 100 lbs. or 125 lbs. per square inch, the thickness for each and for each of several diameters being given in tabular form; the calculation having been based upon strength of steel plates between 55,000 and 65,000 lbs. per square inch. The radius of the dished heads is the diameter of the tank. The tanks are to be given a hydrostatic test 50% in excess of the working pressure. Cast iron filters are not designed for pressures higher than 100 lbs.

OLD RETAINING WALL; NEW WALL AT LEFT.

Sanitating a Small City

By W. A. Hardenbergh*

A model health code and compulsory immediate construction of septic closets required in small suburb of Birmingham. Details of closet construction.

In carrying out the sanitation program of the Jefferson county (Alabama) Board of Health, various problems have been encountered in several of the small cities and towns. These problems and the methods employed in solving them may be of interest to the many other places of similar size in the country which are confronted with the problem of improving their sanitary conditions without too great an expenditure of money.

Between April and November, 1921, Leeds, Ala., suffered twenty-four cases of typhoid fever. In the beginning of 1922, there was another flare-up, twelve cases developing in January and February. These out-of-season cases merely illustrate the ideal conditions for disease that existed in Leeds. While many of the wells were in fairly good shape, there was scarcely a sanitary toilet in the place. Open-back privies and open wells were found almost side by side. During every rain, the surface water carried pollution from these insanitary toilets all over town. No piped water was available, nor was there more than a slight hope that it would be available within the next few years. If water had been available, the cost of constructing sewers would have been almost prohibitive, as well on account of the large amount of rock excavation as because of the fact that Leeds lies on the watershed of one of the main sources of Birmingham's water supply, and the sewage would have to be given very complete treatment or pumped out of the water-shed.

The county board of health recommended the adoption of a model health code which provided for the elimination of surface toilets and their replacement by septic closets. Future installation of a municipal water supply was provided for, and requirements made for connections to the mains. Immediate installation of the specified toilets was required, and the municipality was authorized to construct toilets where householders neglected to comply with the law, the cost of such construction to become a lien upon the property.

There was considerable opposition to this program among the 3,000 inhabitants of the town, but it is gratifying to note that this has almost entirely disappeared since the work has begun.

Septic closets were specified because of the possibility of their later use as septic tanks, and because no other privy seemed to fill the requirements. Pits are dangerous in limestone formations, such as are found at Leeds; experience has shown that the box and can toilet is not suitable for small town use; neither the concrete vault nor the chemical toilet were deemed suited to this installation.

The Alabama law gives to incorporated towns and cities of this size police jurisdiction for a distance of one and one-half miles beyond the city limits. Within the town proper and the police jurisdiction, were 450 homes, about 100 of which were the property of the Atlas Portland Cement Co., which operates a plant at Leeds.

In designing the tanks to be used in connection with the septic closets, several points were observed. These included the later use of the tank as a septic tank, ease and cheapness of construction, ability to operate under abuse and without much attention, and as great standardization as possible. Sub-surface disposal of the tank effluent was adopted.

As before noted, sewers will not be available for a long time, but running water may soon be. The septic closet tanks were designed large enough to handle the sewage from the average home, so that with water and a flush toilet, the house sewer can be connected to the septic tank, thus giving each home an individual treatment plant. With this idea in mind, elbows were placed in most of the tanks to simplify connections to the house sewers.

It was decided that construction economies effected by the use of only two sizes of tanks would be greater than any extra costs from the use of too large tanks. The two sizes adopted were 270-gallon, for not more than 10 people, and 600-gallon, for not more than 25 people. Except in the case of sewage from the cement plant, no tanks larger than 600 gallons have been required. These sizes are ample for use either as septic closet or septic tank.

Especial attention was paid to reducing the cost of construction. The use of wood baffles allowed the use of a simple, knock-down box form which was more lasting, easier to build, and much easier to take down than the old-style form used in casting tank and concrete baffles at one operation. The life of the wood baffle is really unimportant, for outlets dropping about 14 inches perform practically all the functions of the baffle.

600-GALLON COMBINED SEPTIC CLOSET AND SEPTIC TANK, WITH SEAT RISER AND MANHOLE FORM IN PLACE.

* Sanitary engineer, Board of Health, Jefferson County, Ala.

About $6 per tank represents the saving on the 270-gallon tank by the use of the wood baffles. Forms have been used more than 20 times, but the average life is about 15 times. The life of the old-style form does not generally exceed 5 or 6 tanks. The cost of building the form for the small tank is about $5.

Generous capacity and education are the only means of reducing trouble in septic closets. Both of these have been provided for.

The 270-gallon tanks were originally designed to be built complete for $20. The first few cost about $18 each. These were satisfactory, but additional details approved by the city officials raised this cost. The present actual cost is about $23, but the town charges $25.85 to cover overhead and depreciation of equipment used in the work.

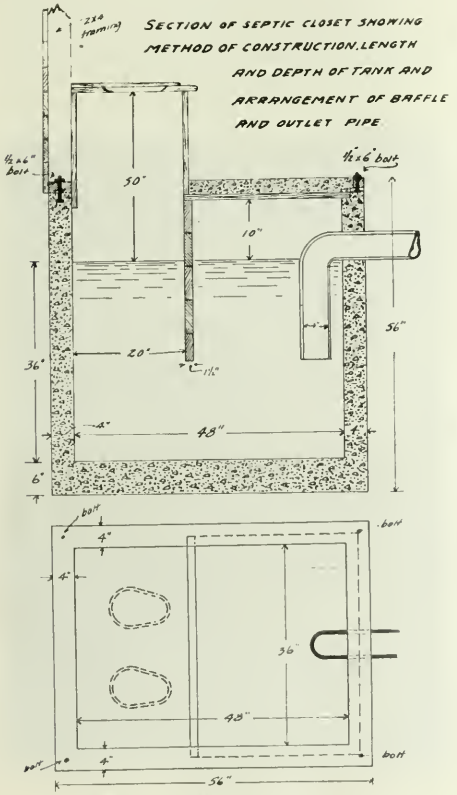
Construction is almost entirely by city forces. A small gang hired by the city does the work. Material is bought and paid for by the city, which furnishes the gang all equipment, charging the property owner for the work. The house owner is free to build his own tank if desired, and some few have done so, but municipal construction is generally cheaper. At first the practice was to pro-rate the actual cost on 10 toilets, assessing one-tenth of the total against each of the 10 owners benefited. A standard charge, found by experience to be fair, but adequate, is now made for each tank. The charge is given itemized in the following table, each item including approximately 10 per cent. for depreciation and overhead.

Digging the hole	$1.00
Placing the forms, and rental for same	2.00
Two barrels of cement	4.70
Broken stone and stone dust	4.00
Mixing and pouring concrete	2.35
Removing forms	1.50
Filling tank with water and testing	1.00
Constructing seat riser, including material	2.25
Tile, sub-surface line and elbow	3.65
Laying tile line	1.00
Finishing tank and placing privy house	2.20
Total charge	$25.85

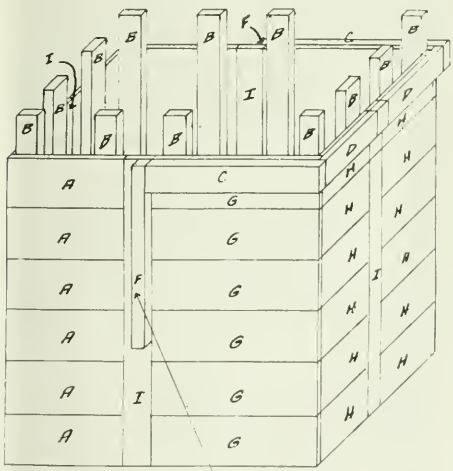
When desired, new privy houses are built. The charge for these averages $17, of which $11 is for material and $6 for labor. The charge of $25.85 covers ordinary repairs to and remodeling of the old privy house.

Labor is paid 17½ cents, and foremen 50 cents per hour. The cement plant at Leeds furnishes the cement at $2.35 per barrel and run of the crusher limestone for $1.35 per ton. At first gravel was used for concrete, but the crushed limestone was found to be so much better that it is now used exclusively. About 5 parts of this, which varies from dust to half-inch pieces, is mixed with 1 part of cement. The resulting mixture is a very fine grade of concrete that sets up rapidly, thus releasing forms promptly. Leaky tanks average about one in five with gravel; with the lime rock the average is about one in 15 or 20.

Water for mixing concrete and filling the tanks has to be hauled from a nearby creek. This consti-



PLAN AND SECTION OF SEPTIC CLOSET.



INSIDE FORM FOR SEPTIC CLOSET.

Lumber required: A—12 pieces 1x8x18; B—12 pieces 2x4x54; C—2 pieces 2x4x28; D—2 pieces 2x4x17; E—1 piece 2x4x4; F—2 pieces 2x2x30; G—12 pieces 1x8x26; H—24 pieces 1x8x16; I—4 pieces 1x4x48; top forms—5 pieces 2x8x30; baffle—5 pieces 2x6x10.

Concrete materials required: 8 sacks portland cement; ½ cu. yd. sand; 1 cu. yd. broken stone or gravel; 4 bolts ½x6 in.

tutes quite a charge, but is the best means available. A Fordson tractor and a trailer are used for most of the hauling.

Items in reducing the cost included the fact that work was started at one end of town and carried through quite uniformly. The personality of the construction foreman and his ability to find short cuts and simple ways of doing things was still more important. It was found cheaper to maintain one building gang of 8 men, with a sub-foreman in charge of privy house construction then to expand the work too rapidly. With fair weather, 60 to 80 tanks per month are built. The cement plant is building its own tanks, but after the same designs as used by the city.

Just after the work of sanitation was started, a hookworm survey of the school children was made. This showed only 15 per cent. of the pupils infected with hookworms or other intestinal parasites. It will be interesting to note, by means of a similar survey in one or two years, the reduction accomplished by sanitation; it will also be interesting to note the agreement in reduction of the filth-borne diseases and of intestinal parasites.

A campaign is now being started to educate the people of Leeds in the use of septic closets and septic tanks, in the hope that trouble along this line can be materially reduced, if not eliminated. A whole time sanitary officer is provided by the city to aid in the work. The campaign will include lectures, personal talks, training of the sanitary inspector and instruction by the nurse stationed at Leeds.

The financial aspects of the installation of septic closets are interesting. An installation of sewers for the town, including either a complete purification plant, or a pumping station and long pipe line, would have cost probably $40,000—an accurate estimate is impossible because of the unknown amount of rock excavation. In addition there would have been the immediate cost of a water system. The septic closets represent a cost of about $10,000, to which should be added about $4,000 for repairs to old and construction of new privy houses. The septic closets can be converted to septic tanks by laying additional tile sub-surface drains at a cost of about $6 per tank.

The work at Leeds has been carried on under the direction of the Board of Health of Jefferson county, Dr. J. D. Dowling, Health Officer. J. M. Spruiell is mayor of Leeds, and James Poe, general foreman of the work. The design of the septic closets and the supervision of the work has been done by the writer as sanitary engineer of the county board of health.

Engineering Societies Oppose State Licensing Laws

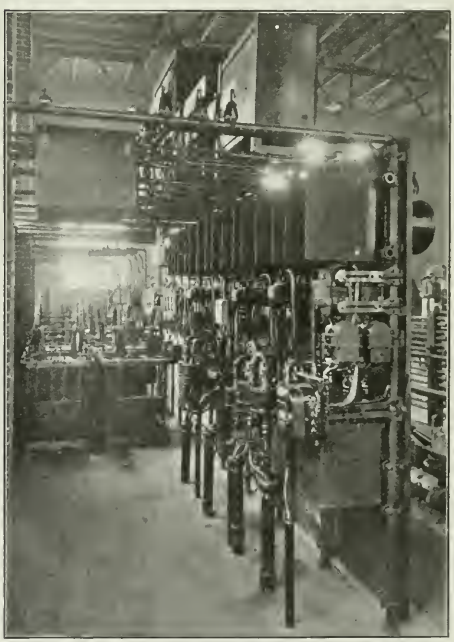
While the American Association of Engineers has been the most active agent in securing the adoption of laws licensing engineers in the various states, several other engineering societies both national and local have opposed such laws. In Massachusets and probably some of the other states the opposition of these engineering organizations undoubtedly prevented the passing of licensing laws that had been introduced in the state Legislature.

Recently in New York and Pennsylvania, both of which have adopted such laws, that in Pennsylvania having just gone into effect and that in New York going into effect next year, local sections of the American Institute of Mining Engineers have started movements for repealing the laws. In Pennsylvania the movement is also endorsed by the Engineering Society of Northeastern Pennsylvania. In Pennsylvania a test case under the licensing law is now in the courts If the law is upheld, an effort will be made to have it repealed at the next session of the Legislature.

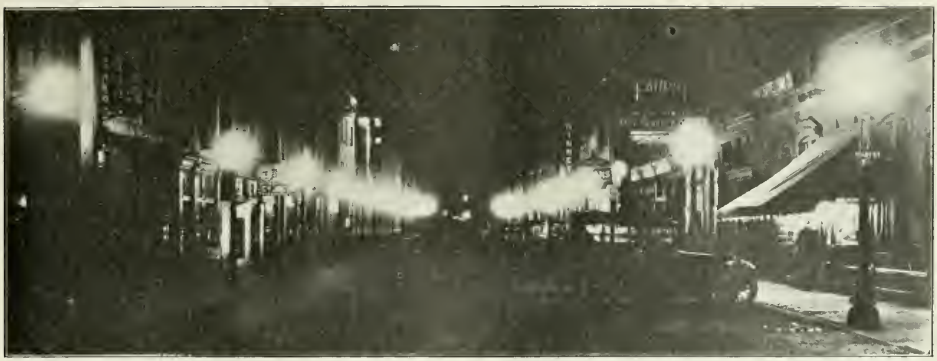
Lima's New Street Lighting

Newly installed system of street lighting, 1,245 light units being placed on sixteen miles of streets. Candle-power, height and spacing varied to meet requirements of each street.

The city of Lima, Ohio, has just completed a new ornamental street lighting system at cost of about $200,000 which comprises 1,245 lighting units and extends over 16.2 miles of street, covering the entire downtown business section and four of the principal residence streets. The



REGULATING TRANSFORMERS AT CITY PUMPING STATION, LIMA.



WEST HIGH STREET, LIMA, O. 400 C. P. LAMPS WITH AUTO TRANSFORMERS, 50 FEET SPACING.

officials believe that this is the most complete and up-to-date system of the kind in the country. Plans and specifications were drawn by Herman Gamper, of Columbus, Ohio.

The installation includes underground wiring and ornamental posts, the current being furnished by a turbo-generator equipment in the municipal pumping station through constant current 6.6 ampere regulating transformers.

One of the most interesting features of the new installation is the graduation of candle power, mounting height and spacing in accordance with the requirements of the individual streets. In the public square the posts are 15 feet high with 1,000 candle power lamps and special refractors that throw the light toward the center of the square. On the main business streets they are 13 feet 3 inches high and carry 400 c. p. lamps. On the minor business streets and in the resident sections the posts are 12 feet 3 inches high and carry 250 c. p. lamps.

In the downtown business section the standards are spaced 50 feet apart but throughout the balance of the system the spacing is 100 feet. In order to obtain the desirable uniform distribution, the Director of Public Service, Elmer McLain, took a firm stand against the request of individual owners for changes in locations of lamps and insisted that each one should go exactly where planned. The result is an unusually uniform distribution of illumination.

It was considered by the consulting engineer to be poor economy to save by cutting down the candle power of the lamps, for this saving is very small as compared with the initial outlay for the installation; but the candle power was used that was thought to be most effective. The consumption during December, 1921, the month of longest nights, was 57,000 k. w. h.

The posts used were the Westinghouse-Cutter Continental post equipped with Sol-lux tops and Monax diffusing glassware. The lamps for 400 candle power and upwards are operated through auto transformers in the capitals of the posts and the 250 c. p. lamps are equipped with Regent C. repeating film sockets. Hazard steel-taped lead-covered cable was used for the underground system and single-conductor rubber-covered and braided cable for the post wiring. The system is divided into 10 circuits. Two of these, which extend throughout the system, include street intersections and the intervals between, and alley intersections, and are on all night. The remaining circuits are turned off at midnight. A disconnecting pothead is installed in the base of each post which, if the post should be accidentally broken, automatically disconnects the broken post, short circuits the line and leaves the rest of the lamps burning.

The alley intersections are provided with special brackets attached to the corners of the buildings and equipped with radial bowl street hoods and operated from the underground system through safety coils. By this new installation the necessity for unsightly overhead pole line equipment has been eliminated, thus adding greatly to the appearance of the street.

The contract for the construction work was let to the Northern Electric Company of Columbus, Ohio, after lively competition among about fifteen bidders.

Activated Sludge in England

According to a recent report of the Minister of Health of England, considerable progress was made last year in establishing the activated sludge treatment of sewage in that country. Experiments have been carried out at Sheffield, Manchester, Birmingham, Stoke-on-Trent, Reading and other places. Sheffield, after running a plant dealing with 1,000,000 gallons of sewage a day for more than 12 months, decided to adopt this for the whole of its sewage and a new plant is already under construction. Agitation of the sludge both mechanically and by air blowing have been tried and both have given good effluents; but the former, which is in operation at Sheffield, gives a lower cost of installation and the works are more easily maintained than with air blowing. In addition to Sheffield, activated sludge has been adopted at Stoke-on-Trent, Reading, Rotherham and East Ham.

Water Mains and Meters in St. Louis

Electrolysis troubles with 36-inch steel main and with cast iron pipe. Twelve miles of pipe cleaned. Cost of setting, maintaining and reading meters. Average and maximum consumption figures for fifty years past.

DISTRIBUTION SYSTEM

Considerable trouble has been experienced with a 30-inch steel pipe due to electrolysis. Last year this line had to be taken out of service on two occasions because of leaks so caused. During the first withdrawal from service two holes which had been plugged with wood the year before had to be repaired. The second shutdown was made necessary by a leak under the car tracks in Broadway, which proved to have been caused by the worst of a serious cluster of pits spread over a length of 30 feet of main. The United Railways spot welded these holes and pits as they had done on previous occasions, and in order to prevent a reoccurrence of the trouble, bonded the rail to a saddle-shaped plate welded on to the pipe.

It is a question with the Water Department whether the increase in number of bonds between the rails and the steel line is not endangering the cast iron system by inducing an increased flow of current at points where it is close to the steel line. Efforts at present are being confined largely to minimizing the amount of damage that can occur during the next few years, since it is the policy of the United Railways to substitute a number of automatic substations supplying small areas for the larger power houses, five of the small sub-stations being already under construction. This substitution of the small stations for the large power houses will automatically solve the electrolysis system by keeping the voltage drop between each station and the farthest point in its area low enough to prevent the leaping of current from the rails to underground structure.

That the problem is a serious one is indicated by the fact that duing the last fiscal year the Water Department spent $1,830 for replacing cast iron pipe at five points which had been destroyed by electrolysis and for uncovering the steel main at three points for the railway company to repair by welding.

Since 1908 the National Water Main Cleaning Company has been carrying out a contract for cleaning the mains of the city and during the past fiscal year completed a contract which included 195 miles of mains. Last year's cleaning included nearly 5 miles of 12-inch pipe, about 3 miles of 30-inch, and 4 miles of 36-inch. Three stretches of 12-inch pipe were tested before cleaning and after cleaning and the efficiencies of flow were found to have increased from 66% to 97%, 62% to 95%, and 74% to 98% respectively; while a 36-inch length that was tested was found to have increased in efficiency from 67% to 98%. From the twelve miles of pipe cleaned there was removed 415 tons of incrustation or 12,114 cubic feet.

It has been found that the inner coating of pipe has sometimes been very noticeably scratched by the blades of the cleaning machine and the supposition is that this will cause a more rapid deterioriation of the pipe after cleaning than after the original laying. In order to obtain data on this point, flow tests have been made periodically on three of the lines cleaned in 1920, one of these being a 20-inch main and the other two being 6-inch mains. The 6-inch mains showed a falling off in efficiency from an average of 95% to an average of 71% in six months after being cleaned, and in two years the efficiency had fallen to an average of about 64%. The 20-inch main retained its high efficiency much longer, the efficiency having fallen from 96% to 90% in two years and five months. These efficiencies were obtained by measurements made with the pitometer. This work will be continued with a view to obtaining more definite and long-period knowledge on the subject.

METERS

The city has in use 9,545 meters, about half of which are ⅝" meters, while the total number of services is 121,019. The number of connections metered has increased during the past ten years from 6.6% to 7.7%.

Each year for the past eight years a certain number of meters have been condemned, presumably because of serious damage or incorrect registration. The number condemned each year has varied from a maximum of 4.8% to a minimum of 1.7% of the total number in service. The number condemned last year was 225, or 2.3% of the total.

The cost of maintaining the meters last year was $17,945, or an average of $1.89 per meter. The total comprised the salaries of six meter men and two repairmen, one man testing, and clerks, which totaled to $12,600; $2,458 for meter repair parts, and the balance for feed and bedding, shoeing and clipping horses, wagon repairs, auto supplies, printing and incidentals.

Reading meters cost $14,582, or an overage of $1.53 per meter, this total comprising $12,672 for meter readers' salaries and $1,910 for the maintenance of 5 Ford cars. The meters are read at least once a month, some of the large ones being read weekly. These readings are made by 8 men who use automobiles, two men in each machine, who also make inspections and report leaks on metered premises as they make their rounds. With a larger percentage of the services metered, the cost of maintenance would be less. In discussing this matter the Water Commissioner, Edward E. Wall, estimates the cost of the annual maintenance of 110,000 meters at $44,000.

During the year, 282 meters were installed and 113 were removed, giving a net increase of 169 meters. The meters are set by the contract method which has proved very satisfactory and will be continued. The cost of setting meters under this plan,

excluding the boxes, was $4.50 each for ⅝" and ¾" meters, $5.00 for 1" meters, $5.50 for 1½" and $6.00 for 2".

Commissioner Wall, in his annual report on the work and needs of the Department, states reasons for concluding that it would not be economical at the present time to place meters on all connections in St. Louis. Referring to figures which he presented showing the rates in a number of cities throughout the country together with the percentage of services metered in each, he says: "It could hardly be expected to reduce the water consumption in St. Louis by more than 20,000,000 gallons per day, which would reduce the average daily per capita to little more than 100 gallons, since the average for 40 cities having 80% or more of their services metered is 105.4 gallons, while the average of the 18 highest out of the 40 is 113 gallons.

"Twenty million gallons of water saved per day amounts to 7,300 millions per year, a little less than one-fifth of the total pumping. The reduction in the cost of operating and maintaining the water works brought about by this lowering of the consumption would come through the saving in coal, chemicals and other supplies. There would doubtless be a slight decrease in the item of labor, but not by any means proportionate to the reduction in quantity of water pumped. The cost of coal per million gallons pumped in 1920-21 was $4.50, of chemicals $8.29, to which if we add one-tenth of the cost of labor for purification and pumping 1,000,000 gallons ($.81) we will have a total of $13.60." Other slight reductions might bring the saving to $15.00 per million gallons or $109,500 a year.

To meter all the remaining services in St. Louis would cost more than $2,000,000, the interest on this would be $80,000, the maintenance is estimated at $44,000 and the depreciation at $60,000, making a total of $184,000, which is $74,000 more than the value of the water that would be saved annually.

If, however, by metering the city could postpone for a number of years the expenditure of the millions of dollars that will be required for enlarging the plant, metering would still show financial justification, and had St. Louis begun installing meters ten years ago, as was recommended by the Commissioner, the new works that are now imperative would not have been needed before 1937. As it is, however, the existing works will have reached the limit of their economical service before 110,000 meters could be installed, and reduction in consumption effected by complete metering would come too late to permit postponing the building of the new works.

Commissioner Wall's opinion as to metering is expressed as follows:

"Because the figures at hand do not prove conclusively that a handsome profit would at once accrue to the city through the general installation of meters, it does not follow that placing meters on practically all services is undesirable or unwise. In fact, the only valid reason which can at present be adduced against meters is the prevailing high prices. As soon as it appears that prices have become adjusted to after-war conditions, the city should adopt and carry out the policy of selling water by measurement, just as gas and electricity are sold. The principal reason why this should be done is that it is the only equitable method by which any measurable service should be supplied to the public. By this means each consumer pays only for the water he receives but no more. The only logical explanation of the opposition to water meters is that the objectors feel that under flat rates they do not pay for all the water used and wasted. All other argu-

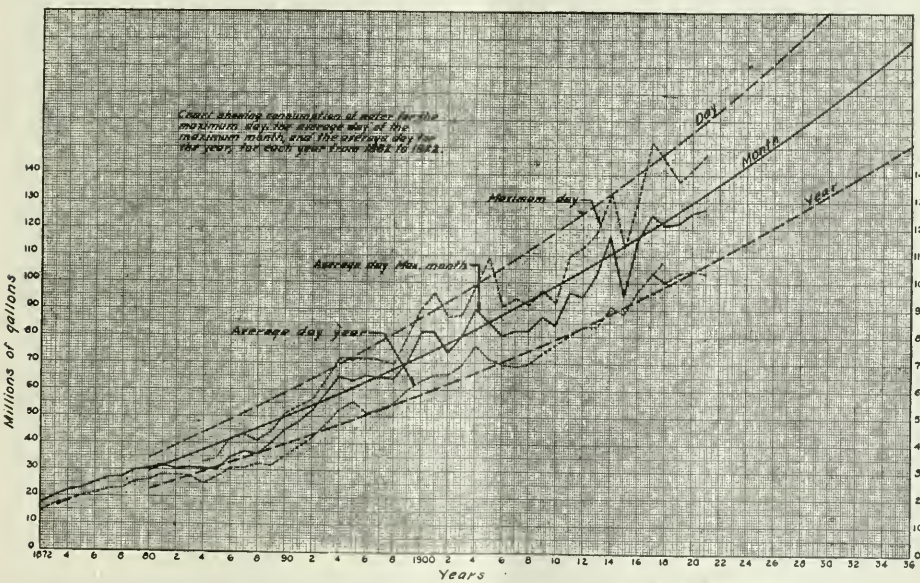


Chart showing consumption of water for the maximum day, the average day of the maximum month, and the average day for the year, for each year from 1872 to 1922.
Day
Month
Year
Maximum day
Average day Max. month
Average day year
Millions of gallons
Years
1872 4 6 8 80 2 4 6 8 90 2 4 6 8 1900 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140

WATER CONSUMPTION FOR AVERAGE AND MAXIMUM DAY AND MAXIMUM MONTH, 1872-1936.

ments, such as those based on sanitary reasons, the plea that lawns would go unwatered, and the fear that tenants will waste water to revenge themselves on the heartless landlords, have been proven to be without foundation in the many cities and towns whose water supplies are fully metered.

PERIODIC CONSUMPTION DATA

The accompanying diagram shows the consumption from 1872 to 1921 inclusive, giving the average daily consumption for each year, the average day for the maximum month of each year and the maximum day of each year. Through each of these sets of records a curve has been drawn and continued to the year of 1936. It is estimated from these records that 150,000,000 gallons a day represents an average daily capacity for the maximum month and that the capacity required for the maximum day is 20 per cent greater than that required for the maximum month, while the capacity required for the average day is .8 that required for the maximum month; or, taking the average for the year as the unit, the average day of the maximum month is 25 per cent greater and the maximum day of the year 50 per cent greater.

Precautions in Dumping Refuse

The Ministry of Health of London, England, has, under date of July 26, issued a "list of precautionary measures for abating and preventing nuisances arising from refuse tips" which it considers to be necessary for all tips or dumps throughout the country. The principal object is to prevent nuisances from fire, rats, flies or smells. These precautions are as follows:

1. Every person who forms a deposit of filth, dust ashes, or rubbish, of such a nature as is likely to give rise to nuisance, exceeding * cubic yards must, in addition to the observance of any other requirements which are applicable, comply with the following rules:—

(1) The deposit to be made in layers;
(2) No layer to exceed † feet in depth;
(3) Each layer to be covered, on all surfaces exposed to the air, with at least 9-in. of earth or other suitable substance, provided that during the formation of any layer not more than * square yards may be left uncovered at any one time;
(4) No refuse to be left uncovered for more than 72 hours from the time of deposit;‡
(5) Sufficient screens or other suitable apparatus to be provided, where necessary, to prevent any paper or other *debris* from being blown by the wind away from the place of deposit.

2. Every person who deposits any filth, dust, ashes, or rubbish likely to cause a nuisance if deposited in any water must, so far as practicable, avoid its being deposited in water.

3. Every person who deposits any filth, dust, ashes, or rubbish, must take all reasonable precautions to prevent the breaking out of fires and the breeding of flies and vermin on or in such deposit.

4. If the material deposited at any one time consists entirely or mainly of fish, animal or other organic refuse, the person making such deposit must forthwith cover it with earth or other equally suitable substance at least 2 ft. in depth.

5. Every person who deposits any filth, dust, ashes, or rubbish must take all practicable steps to secure that tins or other vessels or loose *debris* likely to give rise to nuisance are not deposited in an exposed condition on or about the place of deposit.

6. Sufficient and competent labor must be provided in connection with the deposit to enable the necessary measures to be taken for the prevention of nuisance.

7. So far as practicable each layer of refuse which has been laid and covered with soil must be allowed to settle before the next layer is added.

8. Wherever practicable the person making the deposit must avoid raising the surface of the tip above the general level of the adjoining ground.

9. All refuse must be disposed of with such dispatch and be so protected during transit as to avoid risk of nuisance.

* Appropriate figures should be inserted here, after full consideration of the local conditions. The Ministry will be glad to advise on this point and, in any event, to be informed of the figures adopted.

† Unless the circumstances are very exceptional, the depth of the layer should not exceed 6 feet.

‡ The object of this is to provide that even the surface which is allowed to remain exposed under the proviso to (3) shall be covered up after 72 hours.

Refuse Disposal in Europe

A committee from Glascow, Scotland, made a trip through the Continent last Fall to gather information on methods of dealing with house refuse, but the result of their visit was not made public until a few weeks ago. British engineers were not generally of the opinion that the Continent had anything to teach Great Britain in the way of refuse disposal, and this report apparently confirms that opinion.

Concerning Paris they report that "the value of the visit lay in the observation of avoidable defects." At Nancy they found conditions apparently similar to those at Paris except that a private company performing the work was relieving the taxpayers of a loss. In Cologne no definite facts and figures were available but only statements and claims. At Amsterdam and Rotterdam they found the principal lesson to be the value of centralizing disposal works. However, the Amsterdam plant was found to have been costly in construction and excessively so in operation. Perhaps the most successful plant was that at Rotterdam, but the plant there was similar to that installed by the same firm in a large number of English towns, steam generated by the distructor being used in connection with the municipal electric plant. Figures given appear to show that Amsterdam obtained an evaporation of one pound of water per pound of refuse and Rotterdam about half this amount. However, evaporative efficiencies up to 1½ pounds and 1¾ pounds have been common in England. The plant at Brussels was so poorly thought of that it was little more than mentioned.

In general, while the Glascow committee does not say so, it appears to be the opinion of many who have read the report, including the editor of "Municipal Engineering and the Sanitary Record," that it found nothing in Continental practice which was superior and little that was equal to the common practice in Great Britain.

One Hundred Per Cent. Water Bill Collection

Reports from some cities indicate difficulty in collecting water rents and some have felt that

a change from advance payments of flat rates to post-payments of meter rates would result in still greater losses to the Water Department. On the other hand, a number of water departments report that the amount of water rates unpaid is negligible. We imagine that it is largely a question of the energy of the collector and whether the consumers have or have not been allowed to fall into the habit of deferring payments.

The above is suggested by a statement in the report of Albert L. Sawyer, Water Registrar, of Haverhill, Mass., for the year 1921, in which he states "for the fifth time I am able to report that every water bill sent out during the year has been settled." Of the 8,558 services, 4,777 are metered, so that apparently metering does not interfere with collecting bills in this city. During the year the water was shut off from only one service for non-payment, and from the statement above quoted we conclude that this action was effective.

Federal Survey of Sewage Treatment Plants*

Results obtained in service by fifteen plants, representing all types in common use except chemical precipitation and disinfection. Received reasonably careful and intelligent operation and gave satisfactory results.

During the summer of 1920 the U. S. Public Health Service undertook a survey of fifteen sewage treatment plants located in twelve cities in different parts of the country which were considered to exemplify different typical processes and conditions. The objects of this survey were: 1—to obtain a bird's eye view of the field of sewage treatment; 2—to secure basic data by which the efficiency of service could be judged; 3—to suggest some standard test which might, without undue labor, be adopted at all plants so that results at different plants would be comparable.

The plants selected for the survey were, therefore, those which were felt to be representative, receiving reasonable, careful and intelligent operation. The devices and processes employed at these plants included primary plain sedimentation, septic, hydrolytic and Imhoff tanks; fine screens; trickling, contact and intermittent filters; secondary sedimentation; and activated sludge. It was originally planned to study chemical precipitation and Dortmund tanks, but they were for various reasons omitted from the schedule. At no plant visited was routine disinfection practised.

The basic data were collected by an engineer and a chemist. The engineer learned the details of design and construction of the plant, the population and industrial plants contributing to the sewers, and other factors bearing upon the operation of the plant together with the operating details; in some instances making special investigations of the use of sludge as a fertilizer or other subjects. The chemist spent from ten days to over two weeks at each plant analyzing an average of 12 series of 24-hour composite samples, taken hourly before and after each phase of the treatment. The samples were stored on ice during the period of collection and determinations were made by the same chemist (except at four plants), thus assuring identical methods and eliminating the personal equation in the comparison of results from any two plants. No nitrogen determinations other than nitrates were made at any except the activated sludge plants, where the ammoniacal nitrogen determination is of value in judging the efficiency of the aeration.

The plants surveyed were as follows: Imhoff tanks and trickling filters without secondary sedimentation at Atlanta, Georgia and Columbus, Ohio; plain sedimentation and Imhoff tanks, with contact beds and final intermittent filters of fine cinder or sand at Alliance, Ohio; Imhoff tanks and contact beds at Canton, Ohio; hydrolytic tanks, fine screens, trickling filters, secondary sedimentation and sludge digestion tanks at Baltimore, Maryland; Imhoff tanks, trickling filters and secondary sedimentation at Rochester, New York, Fitchburg, Massachusetts and Lexington, Ky.; septic tanks, trickling filters and secondary sedimentation at Reading, Pennsylvania; Riensch-Wurl screens, followed by Imhoff tanks and disposal by dilution without oxidation at Rochester, New York; activated sludge plants at Houston, San Marcos and Sherman, Texas. At Alliance and Canton, Ohio, were glass-covered sludge drying beds.

The average amount of sewage treated was about 94 gallons per capita, nine cities having smaller flows and six larger, six of the total being within 10 per cent. of the average, five others within 25 per cent. and the remaining four differing from the average by 36 per cent. to 38 per cent. The number of people served per sewer connection averaged 5.4 per cent.

* Abstracted from an article in Public Health Reports for June 23, 1922, by H. H. Wagenhals, Associate Sanitary Engineer of the U. S. Public Health Service.

The character of the sewage at the plants varied widely. Suspended matter ranged from 101 to 297 parts per million, averaging 174. Sewages with less than 100 parts per million are seldom encountered nor are there many municipal sewages carrying more than 297 parts except at plants where an unusual amount of industrial waste reaches the sewers.

Suspended matter was determined both in Imhoff glasses and by the Gooch crucible. The former gave settleable solids ranging from 1.9 to 4.9 c. c., which did not correspond very closely with the suspended matter as determined by the crucible. The Imhoff glasses gave readings of 4.8 c. c. with sewage containing 261 parts per million of suspended matter, while only 2.7 c. c. with sewage containing 297 parts and 2.0 c. c. with sewage containing 101 parts and others containing as high as 226 parts. The Gooch crucible method was considered much more reliable than the Imhoff glass.

The oxygen consumed values by the 30 minutes in boiling water method, ranged from 24 to 69 parts per million, averaging 44.

The five-day biochemical oxygen demand averaged 114 parts per million, with a range between 67 and 190.

IMHOFF TANKS

The Imhoff tanks removed on the average 59% of the suspended matter, and below 60 at only two plants; the figures at these plants, 37% and 40%, pulling down the average considerably.

The biochemical oxygen demand was reduced 42.5% and the permanganate oxygen consumed 36%. It is interesting to note that the reduction of the five-day oxygen demand was greater than that of the oxygen consumed. Studies by the U. S. Public Health Service at Cincinnati have indicated that removal of solids affects oxygen consumed to a much greater degree than it does oxygen demand.

Considering the amount of suspended matter in the effluent, which is more important than percentage removal, the Imhoff tank effluents at half the plants contained between 60 and 70 parts per million, while the highest of the fifteen plants was 119 and the lowest 40. Detention periods for normal flows averaged about 4 hours calculated on total displacement basis, and the velocity 0.6 foot per minute on the same basis.

With but one or two exceptions, most of the tanks foamed at one time or another, but this was more of an occasional nuisance than a serious difficulty and relief could be obtained by withdrawing the sludge, which method was accepted by all the plant operators as the only one giving permanent relief.

The capacity of the digesting chambers below the slot averaged for 10 of the 12 installations 1.1 cubic feet per capita served, the other two having capacities of 2¼ to 2½ cubic feet.

TRICKLING FILTERS

At six plants the trickling filters were preceded by Imhoff tanks, at one by hydrolytic tanks with a few Imhoff tanks, and at one by a septic tank. The depth of filters ranged from 5 feet to 10 feet but was between 5 and 6 feet in six of the eight plants. The rate of filtration of four plants was below 2,000,000 gallons per day and the other four above. The physical appearance of the effluent was good except from one plant, where there was considerable pooling. Some of these filters had been in continuous operation 10 to 12 years with very little expense other than occasionally going over the surface with a pick or harrow or flushing with a hose.

Although the raw sewages had a wide range of concentration, the effluents of the trickling filters were all so similar in composition that they might have come from the same filter on different days. As the filter is an oxidizing device, its efficiency must be judged not by the amount of suspended matter but by determinations involving the presence of oxygen. Those made were oxygen consumed, oxygen demand and nitrogen as nitrates. The last is considered of little value unless the amount of nitrogen in other forms present in the influent is known. Omitting the clogged filter, the oxygen consumed values fell within the range of 7 and 19, and the five-day oxygen demand between 4 and 20. The one clogged filter had an oxygen consumed value more than twice the average of the others and an oxygen demand value about 2½ times as great as the maximum for the others. The reduction of the methyl orange alkalinity was at no plant under 30% and at one plant was 92%, reducing from 99 to 8 parts per million. This same reduction in alkalinity was found in all properly operated oxidizing devices, such as the contact beds and aeration plants of the activated sludge process.

CONTACT BEDS

While the results of the contact beds at Alliance and Canton were not equal to the average of the trickling filters, they were entirely satisfactory for ultimate disposal with the dilution factors available. The oxygen consumed values were 11 and 18 respectively and the oxygen demand values 20 and 37. At neither place are these filters operated during the winter months.

FINE SCREENS

"The analytical methods used in the survey failed to show any accomplishment by the screens at Rochester during the period of the survey. Suspended and settleable solids and oxygen consumed were slightly higher in the effluent than the influent and the oxygen demand was slightly lower, but in none of the determinations was the difference of any significance. Computing from the screenings collected back to equivalent solids, the removal amounted to less than 1% or 2%." A rotating drum screen in Baltimore removed solids likely to clog the sprinkling filter nozzles and their efficiency is best represented by a reduction of about 87% in nozzles cleaned after the installation of the screens.

ACTIVATED SLUDGE

The activated sludge plants studied were two at Houston, one at San Marcos and one at Sherman, all in Texas. The two latter are quite

small, the San Marcos plant treating less than 200,000 gallons a day. The latter plant was visited every day by a general utility man who oiled the machinery and made a brief general inspection. The influent was a weak domestic sewage which had been previously passed through a septic tank. After this double treatment the effluent contained about three parts per million of suspended matter, and oxygen consumed value was about 8 and the oxygen demand about 16, with ample contained oxygen in the form of dissolved oxygen and nitrates to more than satisfy the demand. The annual cost of operation was about $1,400, or $20 per million gallons or $.56 per capita served, the contributing population being about 2,500.

Discussing the practicability of activated sludge plants for smaller communities, Mr. Wagenhals believes that too much emphasis has been placed on the so-called automatic operation of other types of sewage treatment devices and that none of them will work satisfactorily without attention, and he suggests that there is a distinct inherent advantage in a process that necessitates some attention. Motors and air compressors cannot run day after day without at least being oiled and to insure a daily visit to the plant is an important advantage. He even suggests that the activated sludge process may find its greatest field of usefulness in small installations rather than large ones, the sludge problem being greatly reduced in small installations where the amount is not sufficient to make possible the recovery of commercial value.

The plant at Sherman treated sewage that was extremely concentrated and fresh, receiving large amount of night soil, and the effluent was poor. The installation of a preliminary settling tank might greatly facilitate operation of the aeration plant. The two Houston plants produced excellent effluents and the problem there was the ultimate disposal of the sludge. (Recent tests with sulphur dioxide seem to promise fairly satisfactory solution of this problem.)

UTILIZATION OF SLUDGE

At Alliance, Canton and Rochester the sludge is all used by local farmers, charge being made at Rochester. The benefit of sludge to grasses, wheats, oats and other crops is very evident at Canton. Unfortunately, none of the results obtained by the farmers can be given in quantitative figures. One farmer stated that by actual weight he obtained, with two cuttings, 34 tons of grass from 9 acres treated with sludge, while 40 acres in the same field not so treated totaled only 42 tons. It is admitted that such reports are different from experiences of other places. The author believes that at most sewage treatment plants a local demand for sludge can be created on an actual value basis which will even produce a revenue that will help pay for handling the sludge after its removal from the tanks.

CAUSES OF FAILURE

Sewage treatment plants may fail in operation either because (1) the processes may not in themselves be capable of producing a good effluent; (2) the design of the individual plant may be at fault; (3) it may be poorly operated, or as is often the case, receive no operation at all.

Although opinions have been expressed, even among those familiarly connected with sewage treatment, that the whole system and theory of sewage treatment practices have fallen down, this survey made by the Public Health Service indicates that "there does not appear to be much ground for pessimistic criticisms of general theories of sewage treatment on the basis of their failure to effect adequate purification."

The second cause of failure can be largely eliminated when public and especially city officials thoroughly understand that the designing of treatment plants is a specialized branch of professional engineering and that such plants are not a part of the city's plumbing system.

LABORATORY DETERMINATIONS

The primary function of preparing sewage for disposal by dilution without creating objectionable conditions either at the plant or in the receiving body of water was being accomplished by the plants visited with one or two exceptions. At only two out of the 14 operating oxidizing devices was the color reduced in the methylene blue putrescibility tests of the effluent incubated at room temperature, and at one of these two the samples stood up for from 3 to 8 days. Only four of them had biochemical oxygen demand in excess of 20 and all contained oxygen to partially satisfy this demand. Moreover, the treatment process removed practically all of the settleable solids.

These two results, the reduction of solids and the partial oxidation of the organic matter not removed by such reduction, are the two functions commonly required of such plants. In isolated cases the reduction of bacteria may be desirable for the protection of near water supplies or bathing beaches. This being the case, Mr. Wagenhals believes that two determinations, one for the removal of suspended matter and the other for the reduction in oxygen demand, are the backbone of the laboratory routine of the average plant. With special methods of treatment others may be needed, as for instance the ammoniacal nitrogen determination for controlling the aeration processes at activated sludge plants. Of course, when bacterial removal is a function of the plant, total bacteria counts are essential for the proper operation of the disinfecting process.

Refuse Incinerator Lettings

Bids were received by several cities for refuse incinerators during the first two weeks of August, and figures for four of these were, we are informed, as follows:

Daytona, Florida:

Jones Odorless Crematory Co., 15 ton plant.....	$12,000
Nye Odorless Company, 16 ton plant.....	11,500
Vulcan Incinerator Company, 15 ton 24 hours...	11,365

Sanford, Florida:

Jones 16 ton plant	$13,250
Vulcan Incinerator Company, 15 ton plant	14,250
Nye Plant, 12 ton	11,500
Contract awarded to Jones Odorless Co., at	13,250

West Allis, Wisconsin:

Decarie Incinerator Co.	$32,700
Markmann Incinerator Co.	39,500
Badger Reduction Co.	23,875
Nye Odorless Co.	20,000
Superior Garbage Company	22,125
Dollarhide and Elliot	20,190
Jones Odorless Co.	18,000
Vulcan Incinerator Co.	17,750

All bids under advisement, until the Council secures a site.

Quincy, Illinois:

Jones Odorless Company	$18,000
J. W. Stokes	17,000
Decarie Incinerator Co.	24,900

All bids pending under advisement until a selection of a site.

A New Type of Road Drag

Iowa State Highway Commission uses old War Department materials to make a heavy drag that does some of the work of a blade grader.

A new type of road drag has been devised by the Road Maintenance Department of the Iowa State Highway Commission, the plans having been prepared by O. M. Briley of the Maintenance Department and the first sample having been built by mechanics at the warehouses and machine shop of the Highway Commission. The drag was given its first tryout on the roads of the Iowa State College at Ames and in May started on a tour of the state. Boone county and possibly others have constructed similar drags from unused material lying in its storage piles and warehouses.

The Commission believes that every county store yard contains wheels and axles, beams and miscellaneous material that is rusting away but which, with a little ingenuity and labor, can be put to use by the Road Department, and it is with the idea of suggesting probable ways of utilizing this unused material that the Commission had this machine put together.

The materials used were a pair of old War Department gun caisson wheels with an axle, some eye beams, two or three lengths of cable, two lifting jacks and a small cable drum, almost all former War Department materials. With this combination of material a wheeled road drag was constructed that is heavy enough to do on soft dirt roads some of the work usually done by a blade grader. It is designed to be drawn behind a heavy truck.

The drag consists of two 16-foot channel irons extending longitudinally on the outside of the frame, and two 22-foot channels placed parallel to and equally spaced between these. Three angle irons, each approximately 16 feet long, are fastened under these four longitudinal channels, each with one angle vertical and the horizontal angle on top and fastened to the bottom flanges of the channel irons. Two of the angle irons are set at similar angles to the longitudinal channels, one at each end of the frame, while the third is set diagonally between these and sloping in the opposite direction from the longitudinal axis of the drag. These angle irons are so attached in the frame work thus built up that the two outside ones work the dirt towards the center of the road when the drag is in use, and the middle one works it towards the outer edge. The result of this arrangement is that the front angle iron throws the dirt towards the center of the road, the middle blade, which extends a short distance beyond the inner end of the front drag, picks up the material and works it back again towards the outer edge; while the third or rear blade, which extends further towards the gutter than the center blade, once more throws the dirt back towards the center. This criss-cross motion to which the material is subjected aids materially in filling small holes and ruts and crushing clods. A saw-tooth bar is hinged loosely on the end of the central blade that is nearest the side of the road and acts as a clod or stone remover, all clods that are not crushed and all small stones that are too large to be pressed into the surface being thrown to the extreme outer edge of the roadway and entirely clear of the travelled surface. This bar can be raised entirely out of contact with the surface if desired. It works loosely on a bolt and is provided with a spring, so that if it catches on any obstruction it will yield until dragged by and then spring back again into place.

This frame is dragged behind the truck. In addition to the frame work just described, a pair of wheels and axle are attached by chains to the side channels of the frame so that the wheels rest on the road between the middle and rear angle irons and inside the outside channels. The driver rides on a seat fastened on this axle. In addition there is on the axle a small drum carrying a cable which is attached to the frame, by which the frame can be lifted from contact with the road when it is desired to travel rapidly from point to point without operating the drag.

It is claimed that while it requires a skilled man and constant attention to run an ordinary road drag effectively, almost any one can operate this one successfully, for it automatically takes care of all the variations in the road surface, the long base and criss-cross motion tend to carry the dirt forward from high spots and to fill in low places, and there is no tendency at all to gouge in where the soil is soft or where there is a low spot. New material deposited on the road is picked up easily and slid along for a considerable distance, giving it an even distribution.

PUBLIC WORKS

Published Monthly
at 243 W. 39th St., New York, N. Y.

S. W. HUME, President J. T. MORRIS, Treasurer

Subscription Rates
United States and Possessions, Mexico and Cuba $3.00 year
All other countries 4.00 year
Change of Address
Subscribers are requested to notify us promptly of change of address, giving both old and new addresses.

Telephone (New York): Bryant 9591
Western Office: Monadnock Block, Chicago
A. PRESCOTT FOLWELL, Editor

CONTENTS

CONSTRUCTING SCITUATE RESERVOIR. Illustrated 137
The Wanaque Dam 143
BROWNSVILLE AVENUE RECONSTRUCTION. Illustrated. By Albert N. Dick 144
Specifications for Pressure Water Filters 147
SANITATING A SMALL CITY. Illustrated. By W. A. Hardenbergh 148
Engineering Societies Oppose State Licensing Laws 150
LIMA'S NEW STREET LIGHTING. Illustrated .. 150
ACTIVATED SLUDGE IN ENGLAND 151
WATER MAINS AND METERS IN ST. LOUIS. Illustrated 152
PRECAUTIONS IN DUMPING REFUSE 154
Refuse Disposal in Europe 154
One Hundred Percent Water Bill Collection 155
FEDERAL SURVEY OF SEWAGE TREATMENT PLANTS 155
Refuse Incinerator Lettings 157
A NEW TYPE OF ROAD DRAG 158
EDITORIAL NOTES 159
Water Meters and Economy—State Funds for City Streets—Municipal Inspection of Sewer Connections
Water Main in River Eroded 160
ANNUAL COSTS OF FLORIDA HIGHWAYS 161
Color of Fire Hydrants 161
EMSWORTH LOCK AND DAM CONSTRUCTION. Illustrated 162
STEEL WATER MAINS IN NEW BEDFORD 165
WATER-TIGHT JOINTS IN SEWER PIPES 165
Disinfecting Sewage at Millville 166
TABULATED SEWERAGE DATA 167
RECENT LEGAL DECISIONS 169
NEWS OF THE SOCIETIES 171

Water Meters and Economy

There are two major arguments in favor of metering water services: one, that the only method of charging for water that is equitable and fair to all consumers is to base the charge on the quantity consumed; the other, that useless waste of water means additional expense to the taxpayers or the consumers, that it can be prevented only by making the wasters pay, and that the only way to detect and prove waste is to meter the water that enters each service.

From the point of view of economy alone meters may in some cases cause a loss rather than a saving—the cost of installing, maintaining and reading the meter may exceed the value of the water saved.

However, it is not only the cost of the water now being delivered that must be considered, but also that of a supplementary supply; and such supply may cost two or three times as much per million gallons as the present one. Elsewhere in this issue is presented the explanation by Commissioner Wall of St. Louis why metering, if it had been begun soon enough, would have saved that city several million dollars, but has been deferred until now the opportunity to effect an economy by metering has passed.

State Funds for City Streets

It is quite common for States to contribute towards the cost of highways voted by counties or by townships or other small political units, but State funds are seldom if ever given to municipalities for street work except where the streets form parts of county or State highways and are built, maintained and controlled as such. Mayor Moore of Philadelphia under whose administration nearly 100 miles of streets have been paved at a cost of nearly $2,000,000, is reported to have said in a recent interview: "We could go much further with street improvements if we could obtain some reasonable return from the State for the money paid on automobile licenses. The paving we do is torn up by heavy trucks and automobiles coming from all parts of the State, some of the trucks running a standardized business in competition with railroads and other transportation lines which are compelled to pay taxes in one form or another."

This would appear to be simply a variation of the old problem of assessing pavement costs. Assessing these against the property facing upon the highway improved is the simplest plan but also the least equitable. The editor of PUBLIC WORKS has frequently expressed in the columns of this paper his opinion that paving the main thoroughfares of the city should not be charged against the abutting property, but that the assessment against such property should be limited to the cost of a pavement sufficient for the local needs only—ordinarily the type adopted by the city in question for its minor residence streets; the balance to be paid by the city at large, since the additional durability and resulting cost are necessitated by the general traffic which in no way benefits the abutting property. An exception to this might be made in the case where business property is benefited by the abundant traffic of the thoroughfare, but the difficulty of adjusting an allotment of this kind might be eliminated by considering that the tax paid by the owner on his business included this additional cost of paving.

If this principle is a correct one, and it appears to us that the only logical one is along such lines, it would also apply to the use of city pavements by State traffic using a city street merely as a thoroughfare for going from one part of the State to another. This complication, as well as the congestion of traffic resulting from passing State highway traffic through city streets, is avoided in some States by the general practice of running State highways by, rather than through, the cities along its route. Where this is not done, there would certainly seem to be much justice in the suggestion that the State should compensate the cities for a part at least of the wear of the city pavement caused by through State traffic.

An interesting news item bearing upon this point comes from New Orleans, where the State of Louisiana has begun the maintenance of a street entirely within the city limits. However, the engineer of the State highway commission said that it was the policy of the commission only to build roads up to the municipal lines and not within the cities. "The department is undertaking the maintenance of the Chef Menteur Road (the one referred to above) because it is really a country road and the sole outlet in that direction, although technically it is within the city limits." In Georgia it has been decided that counties may pave roads or streets leading to the county court house, right up to the court house steps, apparently.

Municipal Inspection of Sewer Connections

A report of the city engineer of a southern city of some size for the latest fiscal year reveals a condition which is a serious one and should have received attention long before this; and yet it is one which we fear can be found existing in a number of other cities.

He reports: "Many parts of our existing sanitary sewerage system are now overloaded. The unlawful connection of downspouts from roofs, to the sanitary sewer has largely increased this overloading and must be stopped. Overflows have been cut into storm water sewers from the sanitary sewer to relieve them during the times they are overtaxed, but this is but a temporary relief and should not be allowed to continue, for the constant use of storm sewers for this purpose will be unsanitary and dangerous to the public health."

The sanitary sewers in this town are practically operating as combined sewers, although calculated for dry weather flow only, and the fact that they are gorged is not necessarily any reflection upon the designer or the system, but rather upon the officials who have been in charge of operating the system or others who have permitted a connection of rain water leaders with the sewers.

The discharge of the overflow from these, when acting as combined sewers, into storm water sewers is, we believe, something of a novelty, although overflows to streams from combined sewers designed as such are quite common. Whether this serves as a sufficient relief for the congesting of the sanitary sewers may be questioned, since the same report states that a number of the storm sewers have been ruptured recently from run-off from the streets, one of them having blown up the pavement almost yearly for several years past.

Both of these features of the sewer system seem to indicate a failure on the part of the officials to take any forethought of the results of the heavy rains that occur several times every year. Another indication of the same lack of appreciation of the volume of run-off from a street or even a roof is found in the same city, where a creek which drains a large part of the city is being continually made narrower and shallower by the dumping of refuse along its banks. This naturally and inevitably leads to a flooding of lands and buildings along the creek. The result of these failures to provide for the removal of rain water must be a cost to the citizens directly, or indirectly through the city taxes, of many thousands of dollars a year.

This city is referred to merely because the report quoted has recently reached our desk. We have, however, information concerning many other cities where conditions are similar if not quite so bad. An engineer of a Kansas city reports that the connection of roof drains to sanitary sewers is prohibited, but it is known that a great many such connections exist because the flow in the sewer increases nearly 50% after a rainstorm, although practically all the sewers are laid above ground water. An Oklahoma city engineer reports that in his city a vast number of houses have surreptitiously connected the rain water leaders to sanitary sewers and several of these become overcharged with storm water. In this city also connections are made with the storm sewers by means of pipes connected to the manholes of the sanitary sewers near their tops. A large city in Tennessee experiences serious difficulty from the same cause, finding it very difficult to prevent the surreptitious connection of roof water leaders with sanitary sewers.

It would seem to be self-evident that there is only one method of preventing this misuse of sanitary sewers and that is to maintain strict supervision over plumbing of all buildings, requiring that an inspector of the sewer department, or of such other department as may have charge of building construction, inspect each connection with the sewer in buildings in which plumbing has just been installed before this connection is covered up, and imposing a heavy penalty upon any plumber or householder who is found to construct and cover up a sewer connection without its having been inspected by the proper municipal department. Once the connection with the sewer has been made, it is almost impossible to determine not only whether it has been made properly, but even whether it has been made with the right sewer where there are both storm and separate sewers passing in front of the property.

Water Main in River Bed Eroded

Several of the mains of Denver's water works cross the Platte river, and at least one of these, a 20-inch cast iron line, was laid in the sandy deposit in the bottom of the river. A few weeks ago floods in the river washed away the sand covering the pipe line so as to expose it, following which floating debris broke the line so that it had to be replaced. When it was taken up, it was found that the attrition of the sand in the river bed had decreased the thickness of the pipe from 0.8 of an inch to 0.25 inch, showing a loss from this cause of more than 1/2-inch in the sixteen years that the pipe had been in place.

In replacing the line, the new pipe was placed some distance below the bottom of the river and was covered with 36 inches of concrete.

Another cast-iron main, 36 inches in diameter, had been supported upon cement piers in the bed of the river, and after being damaged by the flood was relaid in a trench carried down into bed rock in bed of the river and covered with 24 inches of concrete.

Annual Costs of Florida Highways

Different kinds of roads compared on basis of annual maintenance and depreciation under Florida traffic conditions

The county engineer of Duval County, Fla., George B. Hills, has recently submitted to the county commissioners a report dealing with the suitability of various types of pavement for use in that county. He considers eight types of pavement as follows: Plain shell; shell treated with bindex, dustex or similar sulphide liquors; Augusta gravel similarly treated; Ocala limestone with a bituminous surface treatment; bituminous penetration on a limestone base; sheet asphalt with binder course on limestone base; vitrified brick with bituminous joints on sand base; vitrified brick with bituminous joints on limestone base.

He has estimated the cost of construction and maintenance of these various kinds of roads under traffic conditions as found in Duval county, taking as the unit one mile of road 16 feet wide.

The shell roads are made of oyster or periwinkle shell, which costs approximately $3.50 per cubic yard spread in place. This is satisfactory for light horse-drawn traffic but not for rubber-tired automobiles. They are dusty when dry and wash badly when it rains, and are expensive to maintain. They will last two years under a traffic not exceeding 300 vehicles per day. If sulphite liquid is used as a binder at the rate of 1 gallon per square yard initial and 1/8 gallon at four-month intervals, the life may be extended to five years.

Augusta gravel is a mixture of gravel, sand and clay with some kaolin. The gravel costs $1.52 per ton f. o. b. Jacksonville. It is believed that under traffic not exceeding 450 or 500 vehicles per day, such a road would last 10 years.

Ocala limestone is mixed in several quarries in Florida and is excellent as foundation material owing to its cementing qualities and elasticity. It is recommended that it be used for roads with a thickness of 6 inches, surface treating with ¼ gallon of Tarvia B and 1/3 gallon of Tarvia A, covered with slag or granite chips; to be used as a foundation when a more durable surface is required. The stone costs $2.00 per cubic yard f. o. b. Duval County.

Two and one-half inch bituminous penetration is assumed to have a life, with proper maintenance, of 25 years under a traffic up to 1,500 vehicles per day. Slag or granite could be used as aggregate.

Sheet asphalt would handle any traffic to which the roads may reasonably be subjected and with proper maintenance would last for 30 years.

Vertical fibre brick with bituminous joints on a sand base is estimated to withstand a traffic of 650 or 700 vehicles per day for 25 years; or, if placed on a 3″ limestone base, would carry any traffic reasonably to be expected for 30 years.

On this basis as to first costs, and life and maintenance costs as indicated, annual costs per mile were calculated which are shown in the following table:

Type of Road	Capacity in Vehicles Per Day	Initial Cost Per Mile	Annual Maintenance Per Mile	Estimated Life Years	Average Annual Cost Per Mile	Residual Value
Plain shell	300	$ 3,912.50	$400.00	2	$2,356.25	None
Shell and Bindex	300–350	5,696.00	788.59	5	1,943.24	None
Augusta Gravel and Bindex	450–500	9,293.90	788.59	10	1,733.43	Small
Limestone, surface treated	750–800	8,610.75	786.96	20	1,181.50	$6,000.00
Bituminous penetration	1,500	20,028.00	393.48	25	1,194.60	7,500.00
Sheet asphalt	3,000	32,844.50	350.00	30	1,111.48	9,000.00
Brick on sand, bit. joints	656–700	29,722.30	500.00	25	1,688.89	2,500.00
Brick on limestone, bit. joints	3,000	32,854.30	250.00	30	1,345.14	6,000.00

Mr. Hills does not recommend construction of any more shell roads, but that the county adopt as standard, sheet asphalt or vitrified brick on limestone foundation; or, until sufficient funds become available, that main highways be given such permanent pavements to the extent of the funds available, while secondary roads be given a bituminous penetration surface on 6-inch foundation, and those of still less importance be covered with surface-treated limestone constructed by county forces.

Color of Fire Hydrants

Probably the majority of fire hydrants in the United States have been painted dark green or some other dark color with a view to rendering them as inconspicuous as possible, although some cities have used white and others silver. Objections to these last are that when snow is on the ground it is almost impossible to see the hydrants at night and the firemen may thus be delayed several valuable minutes in connecting up their hose.

Recently the Water Bureau of Philadelphia endeavored to select a paint that would make hydrants as conspicuous as possible under all conditions, so that they could be found quickly by the firemen and also obviate the excuse offered by automobilists that they did not notice the hydrant when they are found violating the regulations by parking too near it. The Bureau consulted with firemen, teamsters, automobilists and traffic officials. Fire department officials considered yellow the best color because it can be seen easily at night and in foggy or rainy weather. Also yellow paint is considered to be a durable color, and it was adopted by the Bureau after having been tried on several hydrants located in the center of the city.

Emsworth Lock and Dam Construction

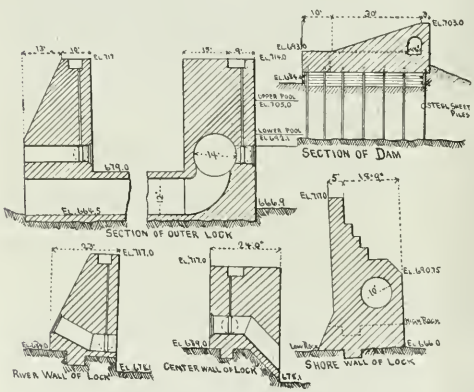
Successive sectional cofferdams aggregating 3,838 lineal feet used for construction of lock and 1,725 lineal feet of low dam. One hundred and eight thousand yards of concrete mixed and placed by special land and floating plants

The Federal improvement of the Ohio river at Emsworth, Pennsylvania, includes the construction of a 110 x 600-foot and 56 x 360-foot concrete lock, and a fixed dam across the main channel of the river to Neville Island and from the opposite shore of the Island across the back channel of the Ohio river with an aggregate length of 1,725 feet. This improvement was made by the aid of 3,838 feet of cofferdam and involved about 109,700 cubic yards of common excavation, 90,760 cubic yards of rock excavation, about 108,000 cubic yards of concrete, 24,500 cubic yards of rip-rap, 60,000 lineal feet of wooden piles and 2,740,000 pounds of steel sheet piles. The contract was awarded to The Dravo Contracting Company, Pittsburgh, which commenced active operations August 1919, and had 98 per cent. completed May 1st, 1922.

GENERAL DESCRIPTION

The work is of simple mass concrete construction with moderate dimensions, the lock walls having a maximum width and height of 24 feet and 51 feet respectively, and the dam a width of 43 feet and a height of 15 feet to the bottom of the concrete. The foundations of the concrete walls are carried down to solid rock at distances below the crest of the dam varying from 18 feet at the up-stream end of the lock to 33 feet for the river dam, and 23 feet for the shore wall. The low water level, elevation 688, is 15 feet below the crest of the dam, and 22 feet above the lowest foundation.

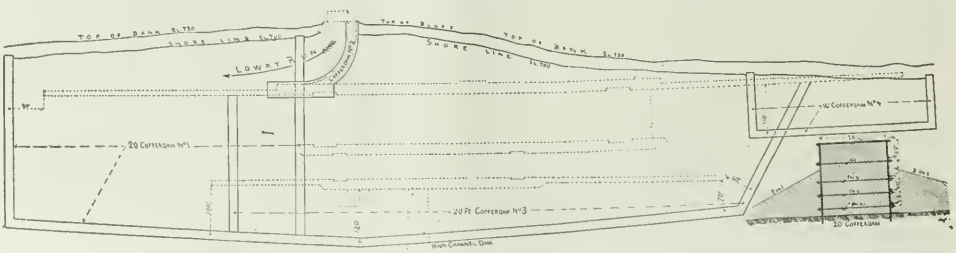
The river bed at the site of the lock and dam consisted of from 5 to 24 feet of earth and gravel overlying the rock bottom and covered with 10 to 22 feet of water with a velocity ranging from nothing, when dams are up, to 8 miles per hour in time of freshet flow. It was, therefore, necessary to execute most of the work in cofferdams, of which there were used 3,838 feet of the box type, 16 and 20 feet wide and about 1,500 lineal feet of single line sheet piles. The box cofferdams of the type commonly used in that vicinity consisted of parallel vertical rows of 2-inch wooden sheet piles from 16 to 24 feet long, nailed to wales and held together with rods—the typical Ohio river box coffer.



TYPICAL CROSS SECTIONS OF CONCRETE DAM AND LOCK WALLS.

COFFERDAMS

The 20-foot cofferdams were braced with five tiers of wales and tie-rods and the 16-foot cofferdams were braced with three tiers corresponding to the three upper tiers of the 20-foot cofferdam. The space between the double rows of sheet piles was filled with earth, sand and gravel dredged from the interior of the cofferdam and the same material was used to make an embankment carried up to the surface of the water on both sides of the cofferdam. The cofferdams were built to an elevation of about 16 feet above low water (elevation 688.0) and the width was made equal to the height. The length of the structure permitted to be built in a single cofferdam was limited by the Government to 1,941 feet of land lock wall and land guide wall, 350 feet of main channel dam and 750 feet of back channel dam, and



PLAN OF COFFERDAMS SUCCESSIVELY USED FOR CONSTRUCTION OF LOCK AND GIRDLE WALLS HERE SHOWN IN DOTTED LINES. ADJACENT END OF MAIN CHANNEL DAM INDICATED NEAR CENTER OF LOCK

special permission was required for construction of more than 350 lineal feet of dam in a single dam. The cofferdams were paid for on a basis of 65 per cent when the cofferdams were completed and dug out and the remaining 35 per cent. after the removal of the cofferdams.

The first cofferdam built was U-shape in plan, known as cofferdam No. 1 and was about 1,500 feet long, with river arm about 640 feet long and 20 feet wide in section. In it there was built about 550 feet of the lower land guide wall approximately parallel to and about 100 feet average distance from the shore line and 185 feet of lower river guide wall. The material inside this cofferdam, as well as the other cofferdam, was excavated by steam shovels and draglines, used in connection with drilling and blasting after the cofferdam was unwatered.

PUMPING AND EXCAVATING

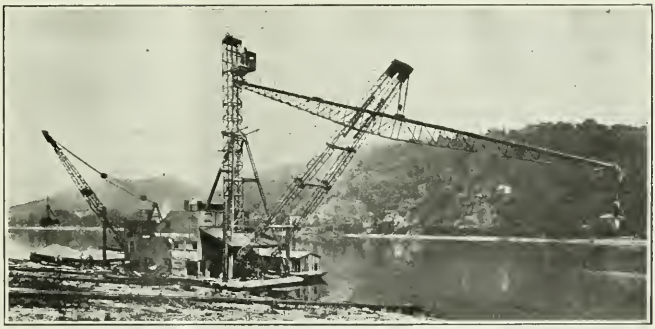
There was installed on the work, a floating pumping plant of centrifugal pumps that were used as required for unwatering the different cofferdams and keeping them drained. Cofferdams No. 1 and No. 3 were unwatered by four electrically driven centrifugal pumps, 14-inch suction and 12-inch discharge. Cofferdams No. 2 and No. 4 were unwatered by one 6-inch and one 8-inch centrifugal steam driven pumps.

The rock excavation was made with eight Ingersoll Rand air drills and the spoil was handled by buckets operated by Bucyrus dragline and three Dravo land whirlers of capacity of 18,000 pounds at 70-foot radius, operated at a hoisting speed of 150 feet per minute on a single line and a swinging speed of 360 degrees in 30 seconds, enabling them to make a complete round trip in a minimum time of about one and one-half minutes.

The material for the most part was loaded in steel skip boxes of from 2 to 5 yards capacity. These skip boxes were hauled on flat cars by steam dinkey to end of cofferdam, where the skips were loaded on barges; the barges towed across the river and their contents dumped in spoil piles. A large number of skip boxes (50 to 75) were required for this purpose, but the saving of rehandling the rock by hand was well worth the outlay for skip boxes. The skip boxes were handled throughout by the whirlers and derrick boats and barges.

After the completion of the guide wall in cofferdam No. 1, the sheet steel-pile cofferdam No. 2 was built enclosing the upper end of the finished portion of guide wall and extending to the river bank, diverting the flow of Lowry run behind the guide wall and discharging it into the river below the guide wall instead of above the guide wall as previously. This cofferdam had about 340 lineal feet of timber walls composed of 12-inch Lackawanna steel sheet piles with arch webs ½-inch thick. The piles, 36 feet long, were driven at an average rate of 70 piles per eight-hour day by one Vulcan No. 2 steam hammer. The cofferdam made with them was about 25 feet wide and 195 feet long, and was kept dry by the use of a single 6-inch centrifugal pump working full time.

Box cofferdam No. 4 16 feet wide and about 700 feet long, was built to permit the construction of 330 feet of the upper guide wall simultaneous with that of the lower guide wall, thus saving some time over what would have been required if this part of the wall had been constructed in main cofferdam No. 3. Main cofferdam No. 3 was 20 feet high and overlapped cofferdam No. 1 by about 150 feet. It was about 1,750 feet in length and was kept dry



FLOATING CONCRETE PLANT WITH 100-FOOT STEEL TOWER AND 150-FOOT DISTRIBUTING BOOM. CAPACITY 600 YARDS IN 10 HOURS WITH 6-MAN CREW.

GENERAL VIEW OF LOCKS, SHORE WALL AND PART OF DAM AND FLOATING EQUIPMENT

by one 12-inch centrifugal pump at about full capacity.

FLOATING CONCRETE PLANT

About 50,000 yards of concrete required for the lock and guide walls was mixed and placed by a movable plant installed on a 40 x 110-foot steel hull 7 feet deep that was moored in the river alongside the cofferdam. The same plant was also used for 28,000 yards of concrete in the dams and their abutments.

Part of the concrete for the lock was placed by a 1-yard mixer and 80-foot tower mounted on a wooden base with 14-foot gauge track. This plant was located between the walls of the large lock and moved to the full length.

The main mixing plant was a permanent unit made up of a steel hull 40 feet by 110 feet by 7 feet, 6 inches deep. On one end of this hull is a Dravo Steel Whirler with 10 x 12-inch triple drum engine, swinger and a 90 foot boom, which handles a 2-½-yard clamshell and feeds the sand and gravel to the bins. Bins, 1-½ yard mixer and 100-foot tower are located on opposite end of hull and a permanent bridge supported by an A-frame delivers concrete a distance of 150 feet beyond the bow of the boat; an additional 60 ft. to 80 ft. of trussed concrete chute was used to carry the concrete from the end of the bridge to the walls. This plant has a capacity of about 75 yards per hour and was used on both the lock and the dam. The mixer, cement elevator, and tower hoist are all connected to and operated by a 14 x 16 inch Erie engine, located approximately in the middle of the boat. The boat is equipped with two 70-hp. boilers.

Cement was delivered to this plant in 2,200-barrel covered steel barges; sand and gravel in steel barges containing from 500 to 600 tons. The mixer boat is equipped with power capstans to facilitate the handling of these barges of material alongside. The entire outfit of mixer boat, two barges of sand and gravel and barge of cement have been held and concreting operations continued with mixer boat lying broadside of the river in a current of such magnitude that an artificial head of about two feet was created against the upstream side of the boat. This current was estimated at about 6 miles per hour or more.

The concrete mixer discharged to a bucket in the foot of the hoisting tower 100 feet high. The bucket was elevated in the tower and dumped its contents into a chute carried on a pair of steel trusses 150 feet long that were inclined one to three from the horizontal, pivoted at the upper end to the tower, and suspended near the center by a five part tackle and steel links and guyed to the hoisting tower 60 feet above the deck, where the latter was connected to the top of steel stiff-legs. There was provided at the lower end of the trusses, a movable radial chute through which the concrete was spouted to required position in the forms.

The barge was equipped with a 14 x 16-inch Erie single cylinder steam engine, a 50-horse power Lambert bucket hoisting engine with 26-inch drum, and 9-½ x 10-inch double cylinder three-drum Lambert hoist for the boom and bridge, two 4-½ x 5-inch double cylinder Ball engines for the capstans, and two 10 x 8 x 12-inch American Service pumps, one March 5-½ x 8 x 12-inch boiler steam pump, one 200-hp. Cochrane vertical open feedwater heater, and one 10-½-inch Westinghouse air compressor.

The whirler was equipped with a 10-½ x 12-inch double-cylinder three-drum Lambert hoisting engine, and a 6½- x 10-inch double-cylinder Lambert swinger engine, having a capacity of ten tons at 70 foot radius with 45,000 pound counterweight. The hull was counterweighted with 70,000 pounds of ballast at the end farthest from the hoisting tower. The plant was operated by a crew of six men. When in service on the lock, several sections of steel chute supported on light towers of movable false work were added to the end of the suspended bridge, enabling concrete to be delivered at a maximum distance of 225 feet from the hoisting tower. These auxiliary chutes, in sections 45 feet long, were trussed, and weighed about two tons each.

STEEL MIXER BOAT CONCRETING LOCK WALL. PUMP BOAT, DERRICK BOAT AND WHIRLER IN FOREGROUND, BACKGROUND AND AT LEFT, RESPECTIVELY.

About 45,000 yards of concrete in the land guide wall and part of the upper and middle lock walls of the lock were mixed by a movable land plant operated by four men, having a maximum output of 375 yards in one eight-hour day.

The principal materials involved in the work included Iron castings 243,710 pounds; steel 17,584 pounds; forgings 57,730 pounds; bolts 57,920 pounds; bronze 844 pounds; reinforcing 2,838 pounds; structural steel 163,173 pounds; common timbers 335,210 feet B. M.

The work was concluded under the direction of Major J. Franklin Bell, United States Army.

Steel Water Mains in New Bedford

Large opening cut in 36-inch steel pipe twenty-two years old permits inspection of interior. About half the inside pitted.

The Water Board of New Bedford, Mass., about twenty-two years ago laid a 48-inch steel force main and recently had opportunity to determine the condition of this main. A new 48-inch cast iron main is being laid and connected with the old 48-inch steel main, which required making a 36-inch opening in the steel pipe.

"An examination of the piece which was cut out of the steel main," said Superintendent Coggeshall in his annual report, "indicates that the main is in as good condition as might be expected after 22 years of service. The outside of the pipe is in perfect condition but about half of the area of the inside is more or less pitted. Some of these pittings are small in area and quite deep (the deepest being about 1/8-inch or approximately 40% of the original thickness), while others are of large area and very little depth.

"Assuming that the whole of the steel main is in similar condition, we may expect about ten or fifteen years more service from this pipe. Before this time a new main should be laid from the 48-inch main at Beaver Dam to High Hill reservoir to be ready for use when the steel main gives out. A 'Y' branch and gate in the new main have been installed for this purpose, so that the work can be continued without interfering with the use of the present 48-inch cast iron main.

"Mr. Conrad's report of the condition of the steel main, as indicated by the piece which was removed, is herewith presented:

An examination of the interior of the 48-inch steel force main immediately adjacent to the gate near where the Middleboro road crosses the line, at what is known as Beaver Dam, disclosed that the interior is tuberculating considerably and that almost without exception wherever there is an accumulation of iron oxide there is a depression or pit in the wall of the pipe which varies in depth from 1/64 to 1/8 inch and there are some that would go beyond 1/8 of an inch in depth. In the pipe itself it would be unwise to disturb these tubercles, as unless the surface was thoroughly cleaned and a protective coating put on, the rate of growth of the pit would be accelerated.

At the place where the interior of the pipe was examined, a piece of pipe about 36 inches in diameter was cut out to provide for a cross connection with the 48-inch cast iron line, which is being constructed to connect with the 36-inch pipe at City Line and Acushnet Ave. A calibration of this piece of pipe would indicate that the thickness of metal runs fully as heavy as was called for, namely—5/16 of an inch. It was not attempted to count the number of pittings in this piece of plate, but there are at least 200 and probably 250 or more places from ¼ to 30 square inches in area scattered over the interior surface, which vary in depth from 1/16-inch to 1/8-inch, which means a reduction in the thickness of the plate at these points of from 20 to 40 per cent. It is probable that the major portion of this pitting occurred during earlier years of the pipe in service, and that their growth has slowed up somewhat, but it can readily be grasped that the years longer that the pipe line will continue to give the remarkable service that it has given during the past 22 years are probably numbered, and that probably within the next 12 to 15 years at longest it is likely to begin to give trouble and it may be necessary, because of possible high maintenance and repair expense, either to put in a continuation of the cast iron line from Beaver Dam to High Hill Reservoir, and use the new line when completed for the main pumping line, holding the steel as a reserve, or else put in the cast iron line to High Hill and immediately prepare to replace the present steel line with another of steel, iron, or whatever material at the time appears best suited for the purposes intended.

An examination of the exterior of the pipe would indicate little if any deterioration of the plate on the outside, which means that the soil conditions over the pipe line right of way have been most favorable, and that the necessity for frequent examination on the outside to detect trouble is not going to be so necessary as a frequent examination inside from now on.

Water-Tight Joints for Sewer Pipes

Tests at Carnegie Institute of Technology of bituminous compounds applied under different conditions and by different methods.

The College of Industries of Carnegie Institute of Technology at Pittsburgh has recently made public the result of tests made of the use of bituminous compounds as jointing materials for vitrified clay pipe. These experiments were made by Prof. S. E. Dibble, and are accompanied by chemical analyses of the materials made by Prof. R. B. Leighou. A final report on the test was made in March of this year by Prof. Dibble. From this report the following synopsis of the test has been prepared.

The purpose of the test was explained to be a determination whether or not cement joints and compound joints could be successfully made to stand a 5 and 10 pound gage pressure; also to establish a procedure for making joints to stand a 10 to 20 foot head. "Actual conditions, as nearly as possible, have been carried out throughout the entire test; only tools and methods used in a trench were used. No care was taken to prepare the bell or the end of the pipe in any way."

Tests were made on 4-inch, 6-inch, 8-inch and 10-inch pipes, some with the surfaces at the joint unglazed and some glazed throughout. Cement and sand were used mixed one to one and in one case neat cement was used. Three bituminous jointing compounds were used, the names of which were not given, but analyses of the three were furnished Although there is a material difference in the chemical analyses of the compounds, the report makes no distinction between them by specifying which one was used in any particular test.

A bulletin issued by the secretary of the institute

states that these tests have established "that a proper bituminous compound can be used efficiently in jointing a pipe; that joints made in the manner developed by Prof. Dibble will stand any pressure that the pipe itself is capable of standing, without showing any leaks; that a pipe line so jointed can be thrown out of alignment without causing a leakage at the joints; and that leaks due to poor workmanship can be repaired easily and quickly."

These tests also show quite clearly that if the oakum placed first in the joint is wet, or if the pipe is wet at the time the melted bituminous compound is poured into it, a tight joint cannot be made. As the probability is that use of joints of this kind will be confined largely to wet trenches where the necessity for tightness is greatest, it is apparent that this is a serious objection to the use of the material. The reason assigned for the impossibility of securing tight joints under the condition described is that the water present is turned to steam when bituminous material, heated to a temperature of more than 300 degrees comes in contact with it and this steam in escaping forms open passages in the bituminous material or between it and the pipe. While it is not impossible to prevent the oakum from being wet before or after it has been placed in the joint nor to have the bell and spigot dry at the time of pouring the compound, the effecting of this will add to the cost of the use of the material, and the difficulty of securing this condition with the class of labor ordinarily employed in sewer work lessens the probability of securing tighter joints with this than with the common cement joints.

Where the material was placed in a dry bell, with the bituminous material heated to about 450 degrees and the asbestos joint runner left on for 4 or 5 minutes after pouring, all joints remained tight under 15 pounds pressure, and in some cases 20 pounds left the joints still tight.

It was found that the material should be heated until it was as liquid as water, which apparently meant 450 to 500 degrees, and must be poured rapidly so that it would not have a chance to cool before the joint was entirely filled. In order to prevent the compound flowing into the pipe, a strand of oakum was caulked into the back of the joint. The joint runner can be made of rope asbestos or of clay, as is sometimes used for lead joints in water mains, but apparently the square face asbestos runner was preferred.

When leaks occurred it was found possible to make them tight again by heating the joint material at the point of leak by means of a torch until the material just began to flow, then applying more of the compound which had been heated to a plastic condition and pressing it into the joint against the sides of both hub and spigot, then applying the torch again to the surface of the patch until it just began to flow. Patches made in this way were found to be as tight as any other part of the joint.

In one test, four lengths of 4-inch pipe were jointed together and supported at the two ends and the middle forced about 4 inches out of straight alignment. Under 5 pounds pressure leaks appeared at the bottom of the middle joint, but these were immediately stopped in the way described above. A line of three lengths of 8-inch pipe was jointed and carried across the room by two men, one holding each end, and the joints remained tight under 5-pound pressure, and in another test two lengths of 6-inch pipe which were moved after jointing also remained tight.

In one test the oakum was packed loosely in the joint, but this did not interfere with the tightness of the joint. Apparently also it made no difference as to tightness whether the pipe was glazed or unglazed. A joint poured with the compound at the consistency of thin cream leaked at 10 pounds pressure, and another 10-inch pipe in which the compound was poured very slowly leaked slightly at 5 pounds pressure, indicating the necessity of high temperature in the compound when poured.

The tests also included several using cement and sand. The strand of oakum was caulked into the back of the joint, and Portland cement and sand mixed one to one was used for making the joints. In one case where sufficient mortar was not used, after setting 24 hours, leaks did not develop under 3 pounds but did under 6 pounds. In another test where the cement was brought well over the hub of the pipe and extended out 2 inches on the straight length of pipe the joints showed no leakage under 5-pound pressure, but leaked under 15 pounds. A test of 8-inch pipe was made, using neat Portland cement, extending over the hub and 2 inches out along the straight pipe, and one joint leaked at 5 pounds pressure, and all of them as the pressure was increased above 5 pounds.

Of the three bituminous compounds, one contained 57% of total bitumen (soluble in carbon bisulphide), the second contained 49% and the third 41%. Of the remaining insoluble matter, the first had 40% inorganic, the second 47% and the third 50%. The viscosity at 175 degrees C. varied from 29′ 12″ to 10′ 38″ and the melting point from 74 degrees C. to 105 degrees C. The insoluble inorganic matter, which was presumably the mineral matter added to the asphalt, consisted almost entirely of lime (54%) and magnesia (36%) in the material first described above, but in the second and third compounds was largely silica (69% and 82% respectively) with 24% alumina in the second material and 9% magnesia in the case of the third. In other words, the first sample apparently had limestone dust as its principal mineral ingredient, while the other used pulverized sand.

The Portland cement used was Universal and analysis showed about 64% lime, 19% silica, 7½% alumina, 4% iron oxide and the remainder largely magnesia, sulphuric anhydride and matter lost on ignition.

Disinfecting Sewage at Millville

Millville, New Jersey, has been using liquid chlorine as a disinfectant at its sewage disposal plant for several years, with excellent results. Gas is added to the effluent from the sedimentation tank in the amount of 70 lbs. per day. The effluent averages about 1,400,000 gallons per day. Laboratory tests are made almost daily. The reduction of bacteria usually runs about 99% plus. The annual report of the State Board of Health for 1920 stated that the tests showed an absence of B. Coli in 1 c. c.

Recent Legal Decisions

MATERIALMEN'S CLAIMS AGAINST ROAD CONTRACTOR MUST BE CONSIDERED SEPARATELY

The Arkansas Supreme Court holds, Gave v. Road Improvement Dist. No. 3, 240 S. W. 427, that a statute requiring a road contractor to give a bond conditioned that he will pay for labor and materials furnished, and giving right of action therefore in the name of the district gives a separate and distinct cause of action to each person. A person furnishing labor or material under a contract with the contractor or one of his subcontractors has no relation to a person funishing labor or material under another contract. These claims cannot be added together to give jurisdiction, so that an Arkansas circuit court had no jurisdiction on a bond, where the complaint stated 72 separate claims, all except 4 under $100, though the aggregate amount exceeded the jurisdictional requirement.

KALSOMINED WINDOW SASHES AND WIRED GLASS WINDOWS AS A FIRE PROTECTION

Construing an ordinance of the city of New York requiring proprietors of factories to provide, in addition to appliances for extinguishing fires, "fire-doors and other means of preventing fires," the New York Court of Appeals holds, People v. One Hundred and Thirty-one Boerum Street Company, 135 N. E. 327, 233 N. Y. 268, that kalsomined window sashes and wired glass for windows are of a nature and character so similar to fire doors when directed to the purpose of preventing fire that they may be said to be included within the words "other means" as used in the ordinance. A fire-door is not necessarily limited to exterior openings in a building. But, conceding this, it is a fact that it is used for the purpose of closing an opening in a building and of preventing fire from entering and spreading, and a fire-proof window is of a generally similar construction, devoted to the same purpose, and, fairly, an "other means of preventing fires."

The requirement is held to be one which can be complied with without involving structural changes, since the window sashes could be painted or coated with a fire-proof mixture, and a window pane is of such a temporary and changeable character that it cannot be regarded as a part of the permanent construction of the building.

MISTAKE IN ESTIMATE OF AMOUNT OF CONSTRUCTION WORK—RECOVERY ON QUANTUM MERUIT FOR EXTRA WORK REQUIRED BY CHANGES IN PLANS

The New York Court of Appeals, Foundation Co. v. State, 233 N. Y. 177, 135 N. E. 236, holds that a contract and specifications may contain representations as to existing physical conditions, and, if so, a bidder may rely upon them, even though it be provided that he shall satisfy himself by personal inspection and investigation as to their truth, where because of time or situation such investigation would be unavailing (Faber v. City of New York, 222 N. Y. 255); or statements may be made on which the bidder, because of the language of the contract, cannot rely. He may have agreed that he will not. Then if they are made in good faith he takes the risk of their accuracy. If, however, notwithstanding the agreement as to honest mistake, damages might be recovered from the state for misrepresentations, upon which the bidder might rely, a boring sheet furnished by the state was not such a representation, where it formed no part of the plans upon which the contract was based and was not prepared or used for that purpose. It was an independent bit of information or supposed information in the possession of the state, to which the bidder resorted in making the investigations which it was required to make. If it relied upon this paper, it did so at its own risk. The most it could ask for in regard to this information was good faith.

Where a change in the plans and specifications of a dam, made by the state officials, under a reserved power in the contract, necessitated additional pumps and other items of expense, it was held that the contractor might recover on a quantum meruit for the reasonable value of the work performed.

STATUTORY PROVISION FOR ALLOCATING COST OF STREET IMPROVEMENTS

The Kentucky Court of Appeals holds, Mann v. City of Henderson, 240 S. W. 740, that a statute providing for street improvements to be made at the exclusive cost of abutting owners, but giving the city power to provide by general ordinance that part of the cost shall be borne by the city, does not confer on the legislative board of the city the power to relieve the abutting property owners of all liability, and impose the entire burden upon the city.

GROUNDS OF FORFEITURE OF PUBLIC WORKS CONTRACT

The Tennessee Supreme Court holds, City of Bristol v. Bostwick, 240 S. W. 774, that to constitute the expiration or completion of a public contract, the abandonment or default of the contractor must be such as to be legally binding upon him; temporary cessation of or interference with the work, not acquiesced in by the contractor, will not work a forfeiture, for only the existence of legal causes will terminate his rights under the contract.

ACQUIESCENCE BY TAXPAYERS IN UNAUTHORIZED STREET GRADING WILL PREVENT THEIR ENJOINING COLLECTION OF ASSESSMENTS

The Nebraska Supreme Court solds, Kister v. City of Hastings, 187 N. W. 908, that taxpayers who in a petition request the mayor and council to create a paving district, and while the work of constructing the paving improvement is in progress have knowledge that the paving is not being constructed strictly on the established grades, as required by ordinance, but stand idly by and do not protest nor appear befor the mayor and council sitting as a board of equalization, are estopped and cannot maintain a suit in equity to enjoin the collection of special assessments levied to pay the cost of the improvement.

ACCEPTANCE OF BID BEFORE ADOPTION OF ORDINANCE AUTHORIZING CONTRACT

The Texas Court of Civil Appeals holds, Basham v. Holcombe, 240 S. W. 691, that, in the absence of fraud or bad faith, a city council may accept a bid for public improvements before the money therefor is in the city treasury, and before an ordinance authorizing a contract has been adopted, and hold in abeyance the making of a contract with the bidder until that can be done in full compliance with the charter provisions, where the charter does not prescribe the time within which contracts must be let after bids are received.

RETURN TO MUNICIPAL WATER PLANT

The Indiana Public Service Commission holds that the plant of a municipality operating its own water supply system should earn at least enough to pay for operating expenses, depreciation and the annual retirements on the funded debt and the interest charges thereon, provided the annual retirements and interest charges do not exceed what ordinarily would be considered a fair return on a reasonable value of the plant if operated as a private concern. The net income from the water department should be annually covered into the general fund of the city where it would be available for retirements on the funded debt and for the payment of interest charges.

RULE AS TO DEPOSITS FOR WATER BILLS

The Indiana Public Service Commission considers that there is no objection to a municipality operating its own water plant making and filing a rule requiring subscribers to make a deposit to guarantee the payment of bills for water consumed, providing the deposit is reasonable. Such a rule, if made, should be strictly adhered to, and should give the subscriber the option of making a cash deposit or of furnishing a written guarantee. The Commission authorized the City of Connersville to file such a rule, the rule to provide that in case of a cash deposit it should be returned, less any unpaid bill, when service is discontinued, with interest at the rate of 6 per cent. per annum.

COUNTY ROAD CONTRACTORS' BONDS AS PROTECTION TO SUBCONTRACTORS

When a contractor's bond for county road construction is to the Commonwealth of Pennsylvania, for the use of a county and any other corporation or person interested, the bond is not for the sole protection of the county, but also inures to the benefit of any corporation or person furnishing labor or materials in and about the construction of the roadway. It has been ruled in a number of decisions in Pennsylvania Courts that such a bond covers only such materials as enter into or become a part of the visible work which was directed to be done. The primary purpose of including in the contractor's bond such a clause protecting laborers and materialmen, the Pennsylvania Superior Court says, H. R. Robertson Co. v. Globe Indemnity Co., 77 Pa. Superior Ct. 422, is to secure for the construction competent labor and satisfactory material. It is to the interest of the public authorities that this be done; but the inclusion of such a clause does not relieve subcontractors and materialmen from all care in relation to the matter. "If they are to be protected by the provisions of the bond, it is incumbent on them to see that the materials furnished by them are used in and about the construction of the work and not diverted elsewhere, or by the negligence of the contractor suffered to deteriorate and be condemned. To hold otherwise would open the door to covin and fraud to such an extent that it would be difficult to secure such bonds from responsible surety companies."

AMBIGUITY IN RESOLUTION AND PLANS FOR PAVING FATAL TO PROCEEDINGS

Where an immaterial difference exists between street improvement work to be done by the resolution of intention and that described in the plans and specifications, the proceedings will not be rendered void, but the clear provision of the resolution of intention will govern. This rule, however, does not apply to a case where the resolution of intention is ambiguous and contains contradictory provisions. Where plans and specifications for paving, made part of the resolution of intention by reference, called for additional work, it was held, Southwest Paving Co. v. Wilson (Cal. App.) 206 Pac. 776, that an ambiguity was created which rendered the proceeding void. The property owners would have no certain basis upon which to rely, and persons desiring to bid would have no definite starting point from which to reckon. To insure fair competitive bidding, the bids must be for the construction of the same work, not only as to character, but as to extent as well.

COST OF OPERATION OF UTILITY ACQUIRED BY MUNICIPALITY

The Washington Supreme Court holds, Asia v. City of Seattle, 206 Pac. 366, that under Rem. Code 1915, sections 8005, 8006, 8008, authorizing a city to acquire and operate street railways, but prohibiting the incurring of general indebtedness therefor without submitting the question to the voters, the city cannot, without such submission, voluntarily or involuntarily encroach upon its general fund, or otherwise place upon the taxpayers the burden of meeting deficits of any kind incurred by reason of the carrying out of a plan of purchase or the operation and maintenance of a street railway system. If not so submitted, all obligations arising from such acquisition, operation and maintenance of the utility must be met from revenue.

ASSIGNEE OF ENGINEER'S FEE HELD NOT ENTITLED TO RECOVER ON QUANTUM MERUIT

A city made a contract with an engineer for his services as consulting, designing and supervising engineer in the installation of a sewer system for the city. The engineer assigned his rights to the fee provided to be paid him when the contract had been fully performed. The assignee sued the city on a quantum meruit for the reasonable value of services performed. It was held, Cambridge Co. v. City of Elsinore, (Cal. App.) 206 Pac. 1021, that the assignee acquired no right other than the right to such fee as might become due to the engineer under the terms of his express contract with the city; and that as the engineer never became entitled to such fee, he having failed substantially to perform his contract, the assignee could not recover on a quantum meruit the reasonable value of the engineer's partially performed services.

PUBLIC WORKS.

CITY COUNTY STATE

A Combination of "MUNICIPAL JOURNAL" and "CONTRACTING"

Vol. 53 October, 1922 No. 8

Building Rockaway Boulevard

Roadway 10,000 feet long constructed by hydraulicly dredged fill deposited between two lines of turf retaining walls. Special details developed for delivering materials over new fill and for setting forms on sand

A portion of the highway from Jamaica, Long Island, to Far Rockaway, passes over the marshes at so low an elevation that the tracks of the electric car line laid in the road are occasionally submerged by high tides. During the summer season there is a great deal of travel over this road, and it was in such poor condition last year that it became necessary to make substantial improvements and contracts were awarded last fall by the Highway Department of the Borough of Queens for approximately $300,000 to Angelo Penio of Brooklyn, for the construction of a section about 10,000 feet long, at a materially higher elevation, requiring a fill of from 2 to 10 feet for its entire length; also for paving it with concrete. The work was considered especially difficult on account of the soft ground and the large amount of embankment required on it.

The road is the first of its type in this borough, and its satisfactory completion and maintenance will afford a precedent for a considerable amount of similar roads to be built in the future. It is virtually a causeway 50 feet wide on top and from 2 to 6 feet in general elevation above the original surface of the adjacent marsh. The concrete pavement, 20 feet wide, has a uniform thickness of 6 inches, is crowned 2 inches in the center and is reinforced by single mesh weighing 1.06 pounds per square foot. The road crosses two creeks with girder bridges of a little less than 30-foot spans and will provide for the trolley service that before and during its construction was maintained on the old road parallel and closely adjacent to it.

SOD WALLS FOR RETAINING SAND FILL AT CREEK CROSSING. Pipe from hydraulic dredge shown in white on top of sod wall at right background.

Work was commenced November 1, 1921, and it is expected will be finished early this Fall. The principal quantities involved are about 140,000 cubic yards of fill, 10,000 cubic yards of sod embankment and 22,000 square yards of concrete pavement requiring about 6,000 yards of trap rock and 2,000 yards of sand.

The first important construction item was the

ROAD TO BE MADE BY FILLING SAND BETWEEN THE SOD WALLS.

building of the long, continuous embankment 50 feet wide, with side slopes of 1.2. This was made with a minimum of hand labor. Along each side of the road was laid up a continuous sod bank or dam 5 feet wide at the bottom, 3½ feet wide on top, and from 3½ to 5 feet high. These were built entirely of well bonded 12 x 24-inch pieces of turf about 2 feet thick laid up with sand and earth fill and covered with earth or sand.

The turf was cut alongside the road from the surface of the marsh by men with special spades which had the blades bent at right angles to form a three-sided U-shaped cutting edge open on the fourth side. This was forced horizontally through the ground, removing the turf, which was delivered to a man who, using a special fork having the tines bent at right angles to the handle, placed the turf into position in the dam; or, if the distance was too great, he placed it on a wheelbarrow by which it was carried to the required position. The work was done by gangs of four men who received from 70 cents to one dollar per cubic yard for cutting the turf and building the dam. The sod banks were built at an average rate of about 50 cubic yards per eight-hour day for each gang.

After the dams had stood for at least 30 days, the space between them was filled by hydraulic dredging. The fill was dredged from Jamaica Bay by a 16-inch centrifugal pump and delivered through a maximum length of about 6,200 feet of Jackson Brothers' spiral lockwelded pipe 16 inches in diameter. This pipe was laid on the surfaceof the ground except for a length of about 200 feet adjacent to the dredge boat, where it was supported on scows.

Most of the sand was deposited within 300 feet of the outlet of the pipe, the water immediately draining off through the porous banks so as to leave the top of the fill always exposed. One of the dams was so close to the old trolley line that some of the overflow washed over the latter, and, to prevent this, the water was deflected from this side of the fill as much as possible by the use of 42 x 72-inch sheets of 16-gage iron used as baffle plates parallel to the dam for a distance of about 50 feet from the outlet of the dredge pipe.

The fill was deposited by the 16-inch dredge pump at the rate of about 1,000 yards in 24 hours. A smaller pump was installed near the other end of the section, but did not give as satisfactory results.

SETTLEMENT OF MARSH

The surface of the marsh settled considerably under the weight of the fill, causing displacement of the soft mud and upheaval of the top of the marsh beyond the sides of the fill, which necessitated considerable leveling and grading of the old trolley tracks and required a much larger amount of embankment than was indicated by the original estimate.

The excess fill was determined by measurements made on settling boards after the fill had been completed, these being boards 2 feet square placed about 200 feet apart on the surface of the marsh before the fill was deposited over them. A vertical stake 4 x 4-inch and 16 feet long was driven to refusal through a hole in the center of each board and the elevation of the board indicated on the stake. As the fill was deposited, the settling board was forced down the vertical stake as a guide and after the fill had been completed and settlement ceased a sounding rod or leveling rod was driven down to rest on the top of the board and an accurate measurement from it to the first position of the board showed settlements of from 6 inches to 4 feet below the original elevation, which determined the amount of excess embankment paid for under the contract. It was found that the depth to which a pedestrian standing on the surface of the marsh would sink in 5 or 10 minutes corresponded roughly to that determined by the settling boards.

After the fill was at least 30 days old no additional settlement could be perceived and the construction of the concrete pavement on it was commenced. The outer sides of the turf banks will be protected by a sand revetment covered with 6 inches of steam ashes well rammed to retain the sand and prevent it from being washed away by rains or blown away by high winds to which the open marshes are exposed.

CONSTRUCTING THE PAVEMENT

The 6,000 yards of broken trap rock required for the concrete was shipped by boat from Branford, Conn., to Flushing, and thence was hauled to the end of the contract section in 16 rented 5-yard trucks and dumped from an elevated platform into a hopper, from which the service cars

SOD WALL BETWEEN TROLLEY TRACK AND ROAD LOCATION, AND BETWEEN LATTER AND HOUSE. FINISHED PAVEMENT IN FOREGROUND.

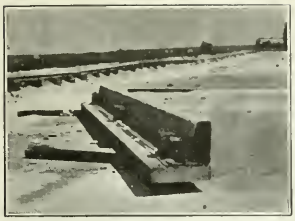
were loaded by gravity. The sand was handled in the same way, but as the accommodations were not always sufficient to provide for the large number of trucks employed, some of the material was necessarily dumped on the ground and then loaded into the service cars by an Erie steam shovel with a one-yard bucket.

From the loading hopper the aggregate was delivered to the concrete mixer by two trains, each having 3 or 6 one-yard, side-dump cars hauled by a Fordson tractor on a 26-inch gage service track which ran alongside the mixer and dumped the materials as nearly as possible in the required position, whence they were shoveled by hand into measuring wheel barrows that dumped them into the mixer hopper. This arrangement was found necessary because it was impracticable to haul the aggregate to the mixer in trucks either on the existing roadway or on the new fill. In order to lay the tracks on the hydraulic fill it was necessary to provide an unusually large bearing surface, which was accomplished by supporting the 5,000 linear feet of 20-pound rails on 3 x 10-inch wooden cross ties 4 feet long and 2 feet apart on centers. It was also necessary to lay planks over the surface of the fill for the moving of the concrete mixer and other heavy plant or trucks.

The concrete was mixed in a Rex chain belt machine with a capacity for 21 cubic feet of wet mix, and was laid at the maximum rate of 284 feet in an 8-hour day. The subgrade of moist sand was trimmed to a convex surface exactly parallel with the finished surface of the pavement and finished with a screed. On this the concrete was laid directly to a depth of 3 inches and screeded, after which the reinforcement mesh was placed on it and the second course of concrete immediately laid and finished with a Lakewood New Way machine traveling on special side forms of the Lakewood type. As these forms could not be satisfactorily held in the hydraulic fill, their lower flanges were bolted to 3 x 10-inch planks making L-shaped cross-sections and were nailed every 3 feet to 2 x 4-inch stakes 5 feet long driven firmly into the sand.

During the Spring and Fall weather the concrete was wet down when necessary with a hose but was not covered with earth or straw. Water for this purpose and for the concrete was purchased form the city, supplied and delivered through a maximum of 5,000 feet of 2-inch pipe.

LOADING PLATFORM, FORDSON TRACTOR ON FLANGED WHEELS, AND ONE-YARD DUMP CARS.



SIDE FORM FASTENED TO PLANKS TO GIVE BEARING ON SAND.

Expansion joints about 100 to 150 feet apart are made at the end of each half day's work and consist of a double thickness of tarred fibre, which was found to give better results than a single thickness at first required. An average gang of 30 men is required to operate the mixer, prepare the subgrade and place and shift the forms, which are kept about 500 feet in advance of the paving machine. Five thousand linear feet of Lakewood forms are provided and are taken up, cleaned and moved forward on the dump cars on the service track.

The road crosses two creeks with bridges having 27 and 29 feet spans respectively, each made with 11 lines of beams solidly enclosed in concrete and carrying a reinforced concrete floor slab. The girders are supported on heavily buttressed concrete abutments with foundations consisting of about 45 12-inch piles, 25 feet long for each abutment. Each abutment was constructed in an open 15 x 50-foot cofferdam made of 4-inch tongue and groove wooden sheet piles 28 feet long, retaining the earth from an excavation 17 feet below water level. The foundation piles were driven with a 1,000-pound drop-hammer pile driver assisted by a hydraulic jet of 80-pound pressure through a ¾-inch nozzle. The same nozzle was used in driving the sheet piles which were carefully assembled between rangers and were driven so closely that the cofferdams were unwatered by an 8-inch centrifugal pump, leaks through the sheeting being calked with oakum and paving pitch.

The work has been executed under the direction of J. L. Rice, engineer in charge, and H. R. Prosser, construction engineer for the contractor.

Sand Centering for Culverts

In an Indian Reservation in California a concrete culvert 30 inches wide and 40 feet long, had a top cover formed of a segmental concrete arch that was cast in place on a well packed sand fill or core covered with tar paper. A small open space was provided on the concrete invert by means of two 6x6-inch boards placed at right angles to form an A shape cross-section with the lower edges elevated on one-inch blocks.

After the concrete top slab was set, a stream of water was passed through the opening of the culvert, washed out the sand core, and floated the 6x1-inch strips free of the culvert in a very few minutes, thus avoiding the expense of permanent form and the difficulty of removing an ordinary wooden form.

Stream Pollution Investigation

Outline of work being done by U. S. Public Health Service on the Illinois river to determine definitely the nature of polluting substances and the fundamental laws that operate in stream purification

An investigation of some phases of the stream pollution problem was inaugurated by the U. S. Bureau of Public Health nearly ten years ago, in accordance with authorization by Congress in 1912. This investigation has included a study of the coastal waters and tidal streams to learn the effect of pollution on the shell fish industry; but studies of stream pollution and stream purification in the inland rivers has formed the most important part of the investigation.

The greater part of the field work has been conducted on the Ohio river and its water shed. These Ohio river studies were interfered with by the war, and no official statement of the information derived from them has yet been published. More recently the studies have been transferred to the Illinois river to determine the general applicability of the fundamental laws observed as a result of the Ohio river work. A brief description of this investigation was given in a paper before the Illinois Section of the American Water Works Association by J. K. Hoskins, sanitary engineer of the U. S. Public Health Service.

He stated that the first object of these studies is to determine the nature of the various important primary types of pollution substances in fundamental terms, and then to ascertain and evaluate the effects of these when discharged into a stream.

Another object is to discover, if possible, the fundamental laws that operate in stream purification. "The observed purification is a progressive process that gives evidence of following definite laws, although these may be complex and not easy of determination. There are many factors that modify the rate of purification and these may be so interwoven as to prevent separate analysis. It is certain, at least, that the old statement, that a flowing stream purifies itself in seven miles, is far from correct. We know that velocity, or time of flow, is a controlling factor, rather than distance. Temperature, both of the water and of the superimposed air, turbulence of the water, and the physical content of the water itself, exposure to light and air, all of these, and others, are factors that affect the rate of purification. Each must be studied under controlled conditions, if sound theories of purification are to be evolved.

"The third object is to determine what agencies are active in the process of stream purification and the significance of the role of each agency in this process. It is necessary to know, for example, what particular organism or constituent is responsible for a specific, observed change in the chemical composition of the various compounds constituting pollution; what rôle such organism or constituent plays in effecting the specific change, and what the significance is of each of these factors. This is in itself a complex problem, of which little is known. We know, for instance, that in the purification process, the death rates of bacteria are a measure of the rate of purification, but we do not know what that death rate is, to what it is due or what all of the factors are that retard or accelerate it. We believe that the plankton, both animal and vegetable forms, play an important role in purification processes, but we know very little about their specific activities and their food habits, or the net effect of the products they generate, such as oxygen. We know that certain classes of organisms break down into simpler forms the organic matter present as polluting substances, but just what these processes are we cannot say. We know that the process of purification depends upon the oxidation of organic matter present, but we know little of the rates at which this oxidation proceeds, or the factors that favor or retard this rate. In the process of purification certain chemical changes take place, but with our present knowledge we have great difficulty in interpreting the meaning of these changes, modified as they are by so many other actual changes."

The work was separated into three main divisions, all of which have been carried on simultaneously. The first division has been conducting studies and experiments on the nature and effect of pollution agencies. Analyses of various classes of industrial wastes and sewage have been carried on to establish, if possible, the relationship between the constituents of the waste and fundamental factors active in the production of the particular waste, regardless of the volume of the waste itself.

The second division has been concerned with the phenomena of stream purification. Detailed data are being assembled dealing with the nature and extent of various kinds of pollution being contributed to certain large streams. Studies are being made of the hydraulics of these water courses, as their velocities of flow and amounts of water contributed by tributaries and other sources of inflow. In addition, laboratories for studying the actual degree of purification being effected at various points throughout their courses are being operated for sufficiently long periods of time to supply reliable data.

The third division of the work has to deal with the effect of intensity of pollution on the public health, principally through the agency of the public water supply. This has involved the study of the present methods of water purification and the efficiencies of such plants under varying pollution loads.

Three phases of the study of the Illinois river now being carried on are hydrometric studies, sanitary surveys, and laboratory analyses of

samples of the river water. The analytical work has followed three principal lines—bacteriological, chemical, and biological. By the first, determinations are made of bacteria growing on gelatine at 20 degrees C. in 48 hours and on agar at 37 degrees in 24 hours and the numbers of B. Coli computed by the decimal dilution method. The chemical work is confined to determination of alkalinity and turbidity and the immediate dissolved oxygen; also biochemical oxygen demand, using the dilution method and incubating the sample for five days at a temperatureof 20 degrees C. and ascertaining the dissolved oxygen present at the end of this incubation period. "We believe this to be one of the most valuable tests at present in use for indicating the degree of pollution and the rate of purification that may be expected to occur from such pollution."

The biological part of the laboratory studies has been designed to supplement the observations so carefully made by Prof. Forbes in connection with the State Natural History Survey and correlate the present findings with them. Consequently only a small part of the biological field is being touched. Monthly samples of bottom sediment are collected at selected points and the nature and amount of the contents of these various sludge deposits are noted. Weekly samples of plankton are collected from many more sampling stations and these plankton forms are counted, identified and recorded. Special attention is paid to the presence of those forms which, in their processes of development, generate and impart oxygen to the surrounding water, thus influencing the rate of oxidation of the organic matter present.

The data have not yet been arranged in final form so that it is not practicable at this time to draw definite conclusions as to the rates of purification of the river, although the results seem to follow the same general trend as those obtained in the Ohio river work.

FUTURE INVESTIGATIONS

At the request of the Surgeon General, Dr. Steven A. Forbes, professor of biology at the University of Illinois, Dr. Edwin A. Jordan, professor of hygiene and bacteriology at the University of Chicago, and Langdon Pearse, sanitary engineer for the Sanitary District of Chicago, have made a joint recommendation as to the plan and policy for future stream pollution investigation work.

These consultants first rehearsed briefly the present status of the stream pollution problem, the lack of power in most of the states to order work constructed under stipulated conditions, the fact that the status and tendency as to the stream pollution problem itself seems to be fairly clear, although in some states no attempt at all is made to regulate pollution by industrial wastes although the indications are that conditions have come to such a pass that even the industries themselves realize that something must be done. It would seem that the states and municipalities may require more full police authority, and more uniform laws and practice.

The consultants, therefore, believe that the Public Health Service has a very definite function to perform in the handling of inter-state problems of stream pollution and the investigation of them and of the underlying principles of stream pollution, sewage treatment, water purification and sanitary science in general; also in co-ordinating the efforts of the various states with a view to securing a definite and uniform policy.

"Our opinion as to the relative prominence of different lines of study is expressed in order of importance as follows:

"(1) Fundamental studies of basic problems leading to results of general application: for example, studies of analytical methods, the laws of oxygen loss and replacement, the laws covering bacterial death rates, laws governing the efficiency of filtration, the efficiency of methods of waste disposal, and the laws governing the removal of colloids, dehydration of colloids, color removal from water supplies, etc.

"(2) Collective studies bringing together scattered observations: for example, assembling from various sources, material relating to stream pollution conditions, sewage treatment practice, water purification, etc., utilizing data available from state and municipal organizations.

"These studies should, if possible, be correlated by enough personal contact, and perhaps laboratory work, to put the methods of reporting and analysis upon a common basis."

In addition they suggest efforts towards standardization of laboratory methods; also a semi-annual review of progress in the fields of sewage treatment, water purification and sanitary science. Efforts to secure co-operation between states in sewage treatment and water purification in connection with inter-state drainage areas, with possible studies of such areas.

Following the studies of the Potomac, Ohio and Illinois rivers, they believe the next step might well be an investigation of the loading of water filtration plants in more detail than in the past, and a study of the relation of sewage treatment to water purification. They might consider standards for water supply and make a beginning in the study of the basic laws covering the chemistry and bacteriology of the treatment of water and sewage.

Metering in Charleston

In his annual report for 1921, J. E. Gibson, manager and engineer of the Water Department of Charleston, S. C., gives favorable reports concerning metering. In January, 1921, 98.4 per cent. of the services were metered, and by July 100 per cent. were metered and this percentage continued until the end of the year. Referring to economies made in the operation of the plant he says: "These economies consisted in the installation of meters on all municipal water supplies, thereby enabling the various departments to co-operate with us in the reduction of needless waste"; other economies consisting in repairs to engines, pumps and machinery generally, and the placing of new filters in operation.

Averaging records for the entire year, it was found that 81.1 per cent. of the water filtered and pumped to the city was recorded by the service meters, while for the month of August 87 per cent. of the water pumped was so recorded. "While this is very gratifying, we hope to account for at least 85 per cent. of the water pumped to the city." The total amount pumped during the year was 2,231,750,000 gallons, of which 621,350,000 was used for domestic purposes and 1,186,350,000 was used for industrial purposes.

The average daily pumpage into the distribution system was 6,120,000 gallons, while the average pumped from Goose creek to the sedimentation basins was 6,410,000 gallons. The difference, or 3 per cent., represents water used for washing filters, dissolving chemicals, making steam, cleaning reservoirs, sedimentation basins and clear water basins and other incidental uses around the plant.

Metering in Augusta

The Superintendent of Canal and Water Works of Augusta, Georgia, J. H. Ferguson, in his report for the year 1921 states that "the report on the operation of the pumping station shows that the meter system has accomplished everything that was expected for it and has proven to be a salvation of the water works system. Comparing the present year's pumpage with the average of the three years prior to the installation of meters, the pumpage shows a decrease of 48 per cent. This reduction represents water that was absolutely wasted and was an economic crime."

The average daily pumpage for 1921 was 5,030,182 gallons, an average daily per capita of 96 gallons. In 1920 the average daily pumpage was 6,459,696 gallons; in 1919 it was 7,841,800 gallons, and in 1918 it was 8,735,630 gallons. This shows a reduction in consumption in these years of 42½ per cent. in spite of an increase in the number of consumers of 1,055 during that time. At present there are 8,848 meters, of which 515 supply industrial consumers.

The saving in the amount of water to be pumped and filtered does not tell the whole story of economy. During 1921 the running time for the two pumps combined was 8,185 hours or 46.7 per cent. of the total time. This means that the pumping has been brought down to within the capacity of one pump, instead of requiring two pumps to be run, one or both of them on part time and at consequently low efficiency.

In order to keep both pumps in condition, the pumps are run alternately, day and night. This is thought by Supt. Ferguson to be preferable to doing all the pumping at night, operating both pumps together, as there is less pressure on the mains and less wear and tear on valves and packing.

Pier Construction, Wells St. Bridge

Large water-tight concrete tail pits for long double-deck bascule span built in cofferdams enclosing multiple deep cyclindrical foundation piers sheeted down by Chicago well process

The long-span two-leaf bascule bridge across the Chicago river at Wells street is the twenty third of the two-leaf bascule type developed by the city engineers. It is a double-deck structure, 268 feet long from center to center of trunnions, carrying two elevated railroad tracks, two street car lines, two roadways between the trusses, which are 41 feet 9 inches apart and 27 feet in average depth, and two cantilever sidewalks outside the trusses at a lower level.

It has a clearance of 16½ feet above water level, permitting small tugs to pass without opening the bridge, and is 231 feet wide between the faces of the substructure masonry on opposite sides of the river, with a navigation clearance reduced to 200 feet by the fenders built outside the masonry. It replaces a swing bridge on the same site that was about 218 feet long over all, including the pivot pier in the center which reduced the channel to two narrow openings instead of the one wide one now afforded. The new bridge was designed and constructed so as to permit traffic to be maintained over the old structure during the erection of the new one.

SUBSTRUCTURE

Each bascule leaf is about 172½ feet long, and is pivoted about 27½ feet from its shore end on a horizontal transverse shaft or trunnion, supported on massive girders and columns in the tail pit which permit the revolution of the bascule leaf to a nearly vertical position in which the heavily weighted shore end is revolved to the bottom of the tail pit while the river end rises clear of the navigable channel. The tail pits, resembling massive hollow piers, are about 48 feet square and 30 feet deep inside, with walls having a maximum thickness of 10 feet at the base, a minimum thickness of 5 feet at the top, and a floor 6 feet thick supported at an elevation of 31 feet below water level on six cylindrical concrete piers carried down to an elevation of 75 feet below water level. The walls and floors are made of 1:3:5 concrete with 10 pounds of hydraulic lime for every bag of Portland cement.

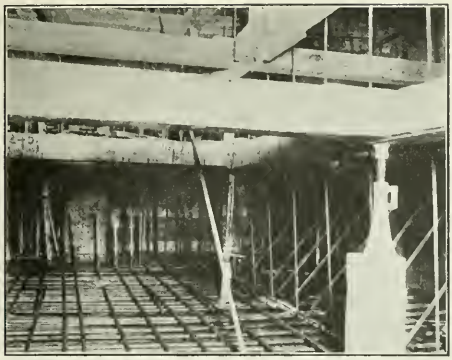
COFFERDAMS

The tail pits and their foundations were constructed in the open in U-shape cofferdams about 90 feet wide over all transverse to the bridge axis, with the wings extending back from the 90-foot face to the shore. The cofferdam wall

was about 4 feet thick with an inner face of interlocking steel sheet piles 45 feet long and an outer face made with a double line of 3 or 4-inch wooden sheet piles 35 feet long reinforced by round piles 40 feet long, the space between them being filled with puddle.

As the pumping and excavation progressed inside the cofferdam, the walls of the latter were braced by longitudinal and transverse 12 x 12-inch timbers arranged in courses from 4 to 6 feet apart vertically and forming 6 x 12-foot horizontal pockets. The first course was placed at water level, the longitudinal and transverse braces all in the same horizontal plane, one of them being cut to clear the other at intersections and spliced across with wooden scabs. It was supported at intersections by vertical posts which, under the lower course, were replaced by adjustable shores having jack-screws on top that were shifted from time to time to permit the concrete to be placed continuously below them. The total excavation for the bridge amounted to 20,901 yards, of which 2,804 yards was rock and masonry and 2,467 yards was earth excavated from the cylindrical foundation piers. The linear feet of piles required totaled 22,100.

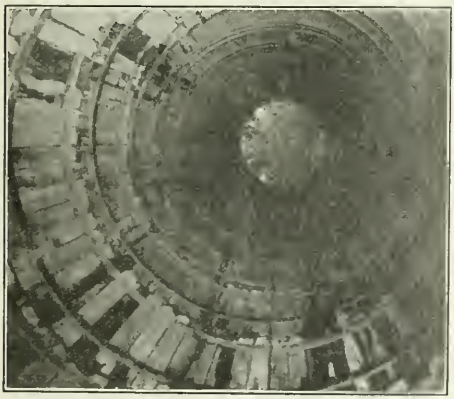
Each tail pit is supported on six concrete cylindrical foundation piers that were at first proposed to be sunk 178 feet below water level to rock bearing, but eventually were seated on hardpan 75 feet below the water surface. These piers are arranged in pairs, one pair supporting the river side of the tail pit, another pair supporting the trunnions, and the third pair supporting the columns. The river piers are 11 feet in diameter enlarged to 19 feet at the bottom; the trunnion piers, 10 feet in diameter enlarged to 18 feet feet at the bottom, and the anchor piers 7 feet in diameter enlarged to 12 feet at the bottom. All are reinforced with horizontal bars at the base and with vertical bars around the circumference of the shaft. Two piers 7 feet in diameter were built to support the abutments beyond the tail pits and two 5 feet in diameter were built outside the tail pits.



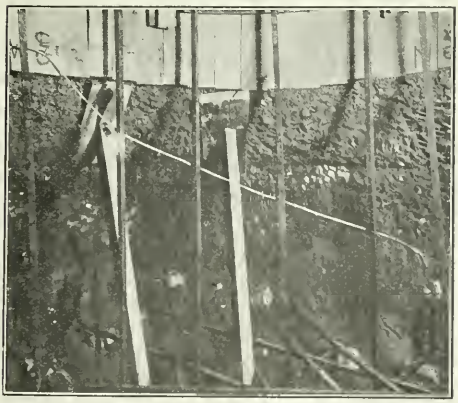
REINFORCEMENT FOR TAIL PIT FLOOR AND WALLS. COFFERDAM BRACING ABOVE SUPPORTED ON JACK SCREWS.

All of the wells for the cylindrical piers were excavated by the standard Chicago well method, the earth side being retained as fast as excavated by vertical 3 x 6-inch tongue and groove wood staves, in 56-inch lengths with the edges beveled on radial lines, each section of the lining was braced with two interior steel rings, each made in sections bolted together through inside flanges, and both lining and rings were left in permanent position when the concrete was placed in the well. The contractor was required to supply six iron extensible trench braces with 2-inch screws and radial segment shoes to support the sides of the shaft in case of emergency.

The wells were filled with 1-3-5 concrete spouted to position and deposited in 4-foot courses, each course being carefully leveled and inspected to insure proper consistency, homeo-



INTERIOR OF 11-FOOT FOUNDATION WELL, SHOWING LAGGING AND REINFORCEMENT IN ENLARGED BOTTOM.



REINFORCEMENT BARS ASSEMBLED IN BOTTOM OF 10-FOOT WELL ENLARGED TO REDUCE MAXIMUM PRESSURE TO 8 TONS PER SQUARE FOOT.

geneity, and the accurate positioning of the reinforcing metal. The specifications provided that if clear water more than 3 inches deep appeared on the surface of the concrete, the concrete should be enriched to proportions of 1:2:3 and placed by hand or by the use of modern dumping buckets.

CONCRETING TAIL PITS

Steel plates, 12 inches wide, driven with vertical angles 3 feet apart were temporarily placeed 6 inches from the inner surface of the wall and shaft forms and the space between them and the forms was filled with 1:2 portland cement mortar placed simultaneously with the concrete to form an outer finish. The steel plates were maintained in position by spacing blocks and were removed as fast as the concrete and mortar were placed.

The bottom of the tail pit floor was heavily reinforced with longitudinal and transverse steel bars with the ends bent up vertically to engage the wall concrete. After these bars had been assembled in position, the vertical shores supporting the interior of the cofferdams were replaced by adjustable struts having jackscrews on top that permitted them to be shifted from place to place as the concrete was deposited, enabling the latter to be applied in a uniform continuous course without vertical holes. As the concreting was carried up, the cofferdam braces were removed to clear it and after the concrete had been placed the sides of the cofferdams were braced against it.

WATERPROOF TESTS

After the completion of the tail pits the tightness of the floors and walls was tested by filling the space between the cofferdam and the tail pit with water up to the river level, producing an unbalanced pressure which did not develop any leaks in the concrete. After the completion of the satisfactory tests the cofferdams were removed and the rubble fill dredged out to the original depth. Each course of concrete in the wall was allowed to set from 12 to 24 hours, all laitance, dirt, etc., was removed from the top of the concrete and it was thoroughly cleaned and flushed with water before the next course was applied.

The work was executed by the Fitzsimmons and Connell Dredge and Dock Co., contractors, of Chicago, under the direction of Charles R. Francis, commissioner of public works; William Burkhardt, deputy commissioner of public works; Alex. Murdoch, city engineer; Charles F. Healy, assistant city engineer; Thomas G. Pihlfeldt, engineer of bridges; Clarence S. Rowe, engineer of bridge construction; and F. A. Berry, engineer in charge.

Freak Stream in Washington

A worthy rival of the famous South American "River of Doubt," which was accused of flowing up-hill, is a stream in southern Washington, according to a correspondent—the company special agent at White Salmon. He sends the following report concerning this amazing watercourse:

A small stream called Bear Creek, flowing from the glaciers of Mount Adams, is a freak. It plays hide-and-seek along its course through the forest, slipping into a cave here, a crevice there, then reappearing below a full-fledged rivulet. Its bed is ice-coated nearly the entire year; on the surface rocks float, in the water logs sink.

The water is bright yellow in one place, red in another, and like bluing where it flows into the Columbia River.

Bear Creek, differing from other streams, freezes at the bottom first instead of at the surface. This is caused by a rocky formation, similar to a corrugated washboard, retarding the movement of the water, forcing the surface to move more swiftly. In this way air-bubbles, carrying freezing temperatures, are shot downward and ice forms. Often in winter the stream flows on the surface while the bottom is solid ice.

This freak creek also contains less water in one part of it than in another as you follow its downstream. A four-foot depth quickly becomes a tiny brooklet by the water disappearing into the porous volcanic bedrock; later it reappears and resumes its course.

The logs that readily sink are a species of blackjack pine with specific gravity heavier than water. They are carried into the creek by landslides.

Rocks seen floating are a sort of pumice, or lava clinkers, released by melting glaciers.

The yellow color is direct from the glaciers; the red is caused by red clay bluffs, and the blue by a deposit of copper quartz through which the stream has cut its bed.—*From "Standard Oil Bulletin."*

Rainfall Intensity Curves

In connection with designing storm sewers for the city of New York, records of rainfall are used which are considered to serve better as a basis for prognosticating the frequency of high intensity rainfalls for the entire city than can be obtained in any other way. These curves are based upon a series of observations covering 52 years, believed to be the longest continuous record in existence.

"The Municipal Engineers of the City of New York" published in 1913 a series of curves showing the intensity of rainfall for different durations and frequencies based upon the records of the Central Park (New York City) self-registering rain gauge from January 1, 1869 up to that time. These curves have been revised by Kenneth Allen, sanitary engineer for the Board of Estimate and Apportionment, to include all the records up to the close of 1920. These revised curves are shown in the accompanying diagram.

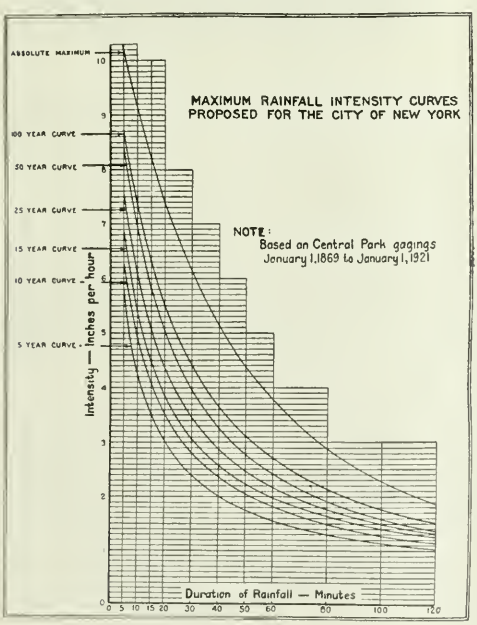
It will be noted that these show intensities of rainfall in storms that may be expected to occur once in five years, once in ten years, fifteen years, twenty-five years, fifty years, one

hundred years, and finally a curve of absolute maximum.

The formulas for these curves are as follows: Absolute maximum, $I = \frac{74,000}{(T+80)^2}$. 100-year curve, $I = \frac{354}{(T+24)^{1.1}}$. 50-year curve, $I = \frac{186}{T+17}$. 25-year curve, $I = \frac{78}{(T+11)^{0.84}}$. 15-year curve, $I = \frac{47}{(T+8)^{0.75}}$. 10-year curve, $I = \frac{43}{(T+8)^{0.75}}$. 5-year curve, $I = \frac{25}{(T+4)^{0.67}}$.

A casual inspection of this curve will indicate how much more expensive would be a system of storm sewers designed to absolutely prevent any flooding of streets than would be one which might be expected to cause flooding by inability to handle storms once in five or ten years. For instance, if we assume a system draining an area such that it would require thirty minutes for rainfall to flow from the furthest part of the area to and through the sewer system to the lowest part of the area, we find the absolute maximum rate of rainfall in inches per hour for that period would be more than 2½ times as great as that occurring once in five years. Knowledge of run off has shown that the percentage of rainfall running off is greater with the higher rates of fall, and consequently the sewer capacity would need to be possibly three times as great. If we take a smaller area, one for instance that could be drained by a flowing time of ten minutes from the upper to the lower boundary, we find a ratio of only two and one-sixth; while for eighty minutes, the ratio again is about two and one-sixth. The cost of the sewers, of course, would not increase as rapidly as their capacity, but the cost of the larger ones might be roughly estimated at 50 per cent. greater than the smaller.

More reasonable would be a design based on the fifty or twenty-five year curve. If we take the twenty-five year curve, we find that on a thirty-minute flow-off area the capacity would need to be only 40 per cent. greater, and the cost possibly 20 per cent. It might very conceivably be considered economical from a purely financial standpoint to increase the cost of a storm water system by 20 per cent. if by so doing we could reduce the number of storm overflows causing damage to basements and public as well as private property from twenty times a century to only four times a century. In fact, 40 per cent. is not an unreasonable factor of safety, in view of the inaccuracies of calculation of flow in conduits, the possibility of deposits in the sewer, etc. The use of the fifty-year curve, equivalent to a factor of about 1.7, or even a one-hundred-year curve, equivalent to a factor of about 1.8 (these are all based on thirty-minute durations) might easily be considered justified.


MAXIMUM RAINFALL INTENSITY CURVES
PROPOSED FOR THE CITY OF NEW YORK
NOTE:
Based on Central Park gagings
January 1,1869 to January 1, 1921
ABSOLUTE MAXIMUM
100 YEAR CURVE
50 YEAR CURVE
25 YEAR CURVE
15 YEAR CURVE
10 YEAR CURVE
5 YEAR CURVE
Intensity — Inches per hour
Duration of Rainfall — Minutes
0 5 10 15 20 30 40 50 60 80 100 120

Street Illumination*

Recent practice in selection of posts and lighting units for various city conditions.

High mounting of lamps (13 ft. to 20 ft.) is generally adopted on downtown business streets and important boulevards where exceptionally high intensities are required. Under these conditions it is desirable to select a unit which will control the direction of the light either by the use of refracting glassware or by specially designed reflectors.

Lower mounting heights are usually adopted for residence streets in order to place the light source below the foliage of trees lining the sidewalks. In this case, lamps of lower power enclosed within diffusing glassware are used.

ORNAMENTAL STREET LIGHTING

The trend of street lighting practice is toward a system of lighting which will add charm to the streets of a city by day as well as illuminate effectively the streets by night. The unsightly overhead equipment is being rapidly replaced by underground cable construction and ornamental posts supporting specially designed lighting units.

Manufacturers of street lighting equipment have developed in the last few years many interesting designs possessing unusual artistic merit which will be found suitable for the varying conditions which exist in different parts of a city.

*Abstract of a paper by L. A. S. Wood, manager of Illuminating Section, Westinghouse Electric & Mfg. Co., before the International Ass'n of Municipal Electricians.

For important boulevards or exceptionally wide business streets two-light or "Duplex" posts may be used, and ornamental posts of this character add considerably to the attractive appearance of a boulevard. For downtown business streets a variety of single-light ornamental posts is offered from which a selection may be made of posts which will harmonize with the surrounding architecture.

On streets where steel poles supporting trolley span wires are advantageously placed, the steel poles may be used as supports for ornamental lighting brackets, thus eliminating the necessity for cluttering up the street with additional posts.

CAST IRON, CONCRETE AND PRESSED STEEL POSTS

In selecting ornamental street lighting equipment a unit should be selected which, while effectively illuminating the streets at night, will be inconspicuous in the daytime, blending harmoniously with the architecture of the surrounding buildings. Since the purpose of the ornamental post is to support the light unit, a slender design is preferable to one of massive appearance. The durability and lasting qualities of the post should also be considered, and experience has shown that a cast iron post, manufactured from a mixture of iron possessing a high tensile strength, is the most suitable for the conditions which prevail on the streets of our cities.

Ornamental lighting standards are also made of concrete and of pressed steel, both of which possess merit. While concrete is probably one of the most durable materials used in building construction, it will be found that concrete posts, unless manufactured with the greatest care and of massive construction, will not withstand the extremes of climate such as are prevalent in the northern sections of the country.

Pressed steel posts which consist of a rolled, fluted steel column with cast iron base and capital—all held together by tie rods—are of necessity massive in appearance and subject to serious injury from the shocks of collisions which would leave a cast iron post undamaged.

LIGHTING UNITS OR POST TOPS

Lighting units or post tops may be divided into two classes:

1. Those designed to diffuse the light and in which the light source is invisible (used for low mounting).

2. Those designed to direct the light into the plane of illumination with maximum efficiency (used for high mounting).

There are several types of diffusing glassware in commercial use, and care should be taken in the selection of a type of glassware which will thoroughly diffuse the light without an undue absorption. A satisfactory glassware with an absorption of from 9 to 15 per cent., through which the filament of the lamp is invisible, may be obtained.

The use of refractors alone to direct the light into a definite plane has been limited to large candle-power, single-light sources, mounted high on ornamental standards; and, where refractors are placed at lower heights, it is necessary for optical comfort to use an outer globe to soften the brilliancy of the light source.

In addition to refractors the light may be redirected by reflectors, as in a recent development known as the "Reflecto-lux." With Reflecto-lux ornamental lighting units the distribution is obtained by upper and lower parabolic reflectors which direct the light outward. The glare from the lamp filament is softened by flashed opalescent glassware, specially designed to impart a sparkling effect to the light.

Typhoid Fever From Clams

The State Department of Health of Connecticut in a recent bulletin reports an outbreak of typhoid fever totalling eighteen cases, seven of the cases appearing to have been caused by the eating of clams contaminated by harbor pollution. These clams had been stored in the Quinnipiac river, which is grossly polluted and which some years ago had been considered to be the cause of infection in typhoid outbreaks in that State.

Toledo Water Works Notes

Collecting water by zones. Pumping efficiency. Deposits on filter sand. Cleaning mains. Mechanical equipment. Metering.

WATER RATE ZONES

In the introduction by W. T. Jackson, Director of Public Service of Toledo, Ohio, to a report for the year 1921 of the Division of Water of that city, he states that he believes the method of collecting water bills "should be immediately changed so that the city may be divided into zones or districts and bills be sent out semi-annually in order that a constant income be forthcoming instead of two annual congestions of water users at the City Treasurer's office as is now the case. This would enable a regular routine of work being maintained constantly and at the same time the Division of Water would always have sufficient funds to properly conduct its financial affairs."

This expression of opinion endorses a part of the report of Frank Miller, water commissioner, in which he says: "Operating revenues are collected monthly and semi-annually, the monthly collections during the year equalling approximately both semi-annual collections, or as $514,000 is $500,000 for the past year. General operation expenses, which are exceptionally heavy during the first six months of each year, create temporary deficits which are not absorbed until late in the year. One of two things is necessary to overcome this condition, namely, the establish-

ment of a stabilizing or reserve fund of at least $200,000, or else the more frequent collection of revenues. The latter would be the most logical, as its advent would seem to permit of more economical operation. A plan whereby the city could be arranged in say four zones of from 10,000 to 15,000 accounts in each zone, would provide operating revenues for current use in the amount of $125,000 or more every three months. This, it is felt, at the same time would reduce the field force required, with the possible exception of a small increase to the office force to carry out the suggestion."

PUMPING EFFICIENCY

Approximately 10 per cent. more water was pumped per pound of coal used during 1921 than the previous year, and the same percentage of increase in efficiency was obtained for the overall station duty. Great care was exercised in the purchase of coal and a very high quality of coal was obtained and at a reasonable cost. Another cause of increased efficiency was that the operation of the engines was conducted under definite procedure, the older and less economical units having been operated less frequently.

Performance tests were made of each pump, and combination tests developed certain efficiency ratings for combinations of pumps at various rates of pumpage. With the use of new equipment which has just been installed in the boiler room it is believed that still greater results and improved efficiency will be obtained.

FILTER SAND

It was reported that all the filter units would need to be resanded this year, since in a considerable number of them the effective size of the sand was considerably in excess of that of the sand first installed and which is considered desirable. The finer sand has been lost during the several years of operation of the plant by being carried over with the wash water, or else has increased in size due to deposits on the individual grains caused by the chemicals used; this latter being due to a great extent to incomplete chemical reaction in the sedimentation basin, the capacity of which is recognized to be too small.

This deposit is apparently due chiefly to the treatment with iron sulphate and hydrated lime. This treatment was used exclusively during January and a part of February "with the result that the sand incrustation increased to 39 per cent. although a modified treatment was used. For the remainder of February, the entire month of March and two weeks in April, aluminum sulphate was substituted, which treatment effected a reduction of the incrustants to 30 per cent. For a part of July, the entire month of August and a portion of September, alum was again used for the purpose of further removing the incrustation from the sand and to assist in the elimination of growths which occurred in the sand during the early summer. The last two weeks in December aluminum sulphate was again substituted, to be continued through the cold months. During the remainder of the year iron sulphate and calcium hydrate were used."

Owing to this heavy deposit of incrustants during the winter of 1920-21 the filter efficiency was greatly lowered and the sand became of such size as to prevent the proper washing of the filters. The alum treatment, which was begun in February, "removed a portion of this coating and rendered the remainder semi-porous. Upon again changing to the iron-lime treatment in May, a cementing action was started which was not thoroughly broken by washing of filters and, aided by the porosity of the sand incrustations, entrained sufficient organic material to become heavy and later start the formation of mud balls in two of the filters. There was no surface indication of this, which caused considerable trouble in July. Large quantities of Bryozoa deposited on the sides and wash troughs necessitated daily cleaning and scrubbing to effect their removal."

The amount of aluminum sulphate used varied from a maximum of 696 lbs. per million gallons in March to a minimum of 237 lbs. per million gallons in August. The iron sulphate used varied from a maximum of 606 lbs. per million gallons in April to a minimum of 223 lbs. per million gallons in July; the amount of hydrated lime used during the same two months being 522 lbs. per million gallons and 225 lbs., respectively.

CLEANING MAINS

A contract had been entered into with the National Water Main Cleaning Company for cleaning a 12-inch secondary feeder for a length of 5,000 feet. This line had been in service thirty-one years and before cleaning was flowing at the rate of 792,000 gallons per day with a loss of head amounting to 34.5 feet in five thousand feet. After cleaning, with the same rate of flow, the loss amounted to 2.15 feet per thousand feet, which means that the same amount of work was accomplished with a decrease of fourteen pounds in pumping head; or with the same amount of pumping energy exerted, the line would have delivered at the rate of 3,160,000 gallons per day; or more than three times as much as before it was cleaned.

In connection with this work a calculation was made showing that the annual cost to operate 5,000 feet of this line before cleaning, based on coal costs at the Broadway station, was $262.20, which was reduced to $16.34 after cleaning; or an annual saving of $245.86. "Should we have reinforced the supply along this street in proportion to the gain in capacity made by cleaning the present line, we would have had to duplicate the present line at a cost estimated to be $14,900 (5,000 feet), interest on this at 5 per cent. would amount to $745; this plus operating costs previously mentioned makes a total annual saving amounting to $990.86. The cleaning of 5,000 feet of this line, our attendant expenses included, amounted to $1,075; therefore in slightly more than one year's time this entire expense will have been assimilated.

MECHANICAL EQUIPMENT

"With the idea in mind that much of the work contemplated to be done within the next four years will be done by departmental forces, it

would seem desirable from the standpoint of facility and economy to purchase more mechanical equipment than is now available for use. Such would include trenching machines, power back-fillers, pavement breakers, air compressors for pneumatic calking, pipe derricks and auto trucks of much larger capacity especially equipped for the handling of large size pipes and special castings. Most metropolitan water works have within the last few years accumulated much of such equipment, notably Baltimore and Detroit.

"An emergency crew consisting of two men per shift of 8 hours each is now available between the hours of 3 p. m. and 7 a. m. for answering all trouble calls, responding to fires, etc. They are furnished with a specially equipped truck upon which is a full complement of tools necessary in taking care of troubles of almost every nature. It would be advantageous to the Fire Department as well as this division to have the fire alarm telegraph installed in the location where this truck is quartered, so that all large fires may be responded to and have this crew on hand in case of necessity."

METERS

During 1921, 1,881 new service branches and 2,805 meters were installed. There are now 52,840 services available for use, of which 46,802 are metered, or 88.6 per cent. Revenues derived from the large meters in the system were decidedly lower last year than any previous year owing to general business depression, and special attention has been directed towards the condition of them. A certain number of the velocity type of meters have been compounded and this has resulted in increased revenue from every service where it was done. The water commissioner, therefore, believes that compound meters should be installed more generally and that every velocity meter in the service which undergoes severe fluctuations should be compounded. In line with this policy, meter specifications have been revised to the extent that all meters four inches and over in size must be compound meters, those below being of the disc type.

Manholes for Valves and Meters

In New Orleans all valves are systematically inspected and tested by actual operation. Each is numbered and a permanent record kept of the results of the inspections. No one is allowed to open or close a valve except an emergency turn-off man, and except under unusual conditions the same man who closed the valve is sent out to open it again. This rule, of course, does not apply to the valve and hydrant inspection and repair forces.

When it becomes necessary to repair a valve in a paved street, a manhole is built around the valve to avoid cutting the pavement for future repairs, and manholes are built over valves in advance of new street pavements.

During the year 1921 the water maintenance office repaired 684 valves, moved 5, removed 5, inspected 4,434, readjusted 418 boxes and built 251 manholes.

In addition to valves, manholes are also built over large meters. During the year the department put in 69 cast-iron services of 4-inch to 8-inch pipe, and with them 56 meters of the same size. It is proposed to place meters as quickly as possible on all unmetered services, using manholes at all meters.

The department is equipped to test and repair about 15,000 meters per year and during 1921 repaired and retested 10,531, besides testing 483 new meters and repairing 600 large 2-inch to 12-inch meters in place.

Public Utilities During the Coal Strike

Figures for the average daily production of electricity by public utilities plants apparently show that the strike had little effect upon the total amount of power produced by such plants. They also indicate what effect the coal shortage had upon the use of other fuels. Curves showing daily production of electricity for 1920, 1921 and 1922 are very similar in appearance, there being a continuous and approximately uniform decline in quantity from January to May, an appreciable rise in June, a decline in July to a little above the May figure and then a continuous rise until November. In the 1922 curve the Spring decrease stopped in April and there was an increase in May rather than a decrease. In that month the k. w. h. totalled about 115 millions in 1920, about 106 millions in 1921 and about 124 millions in 1922. In June of these three years the production increased two million, three million and four millions k. w. h., respectively, and in each fell again to within less than a million of the May figure.

It is seen, therefore, that, although the production of electricity in the spring of 1922 was nearly 20 per cent. greater than in 1921, the coal strike had no appreciable effect upon it. Part of this was undoubtedly due to the fuel that had been stored by the utilities beforehand. But turning to other figures compiled by the U. S. Geological Survey, we find that the amount of natural gas consumed increased from about one and a half million thousands of cubic feet in March to two and a half millions in July, although the total production of electricity was approximately the same in the two months. Moreover, the July consumption of natural gas was approximately 10 per cent. greater than the June consumption although the electricity fell off about 2-1/2 per cent. between those two months. Fuel oil also apparently aided to make up the deficiency, since the July consumption was nearly 5 per cent. greater than the March consumption and nearly 9 per cent. greater than the June consumption. Water power apparently played no part in meeting the coal deficiency, presumably because this was impracticable without the construction of additional hydro-electric units, for which the time was too short. In fact, the amount of water power used decreased to a greater extent in the summer of 1922 than in either 1921 or 1920.

PUBLIC WORKS

Published Monthly
at 243 W. 39th St., New York, N. Y.

S. W. HUME, President J. T. MORRIS, Treasurer

Subscription Rates
United States and Possessions, Mexico and Cuba $3.00 year
All other countries ..... 4.00 year
Change of Address
Subscribers are requested to notify us promptly of change of address, giving both old and new addresses.

Telephone (New York): Bryant 9691
Western Office: Monadnock Block, Chicago
A. PRESCOTT FOLWELL, Editor

CONTENTS

BUILDING ROCKAWAY BOULEVARD. Illustrated 169
Sand Centering for Culverts 171
STREAM POLLUTION INVESTIGATION 172
Metering in Charleston 173
Metering in Augusta 174
PIER CONSTRUCTION, WELLS STREET BRIDGE. Illustrated 174
Freak Stream in Washington 176
RAINFALL INTENSITY CURVES. Illustrated .. 176
STREET ILLUMINATION 177
TOLEDO WATER WORKS NOTES 178
Manholes for Valves and Meters 180
Public Utilities During the Coal Strike 180
EDITORIAL NOTES 181
Society Conventions—Tests on Tight Sewer Joints
Reciprocity in Registration of Engineers 182
Salaries for Sanitary Engineers 182
CONVENTION OF AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS 183
Fuel Oil in Harbors 187
CONVENTION OF NEW ENGLAND WATER WORKS ASSOCIATION 188
RENTAL OF CONTRACTORS' EQUIPMENT 191
Fair Allowance for Force Account Work 192
Testing Bridge Foundations 192
PIPE LAYING BY COMPRESSED AIR. Illustrated 193
Cement Joints for Cast Iron Pipes 194
Floating Islands in Storage Reservoir 195
Mosquito Control by Use of Fishes 195
RIVER INTAKE DIFFICULTIES 196
NEW METHOD OF PURIFYING WATER, by H. W. Clark 197
CONCRETING LIBERTY HIGHWAY TUNNELS. Illustrated 198
TESTS FOR GRANITE PAVING BLOCKS, by Clarence D. Pollock 200
Garbage Reduction in Dayton 201
STATE INDEBTEDNESS FOR PUBLIC WORKS. Illustrated 202
Lead in Cistern Water 204
TABULATED SEWERAGE DATA 205
RECENT LEGAL DECISIONS 207

Society Conventions

We give to our readers this month reports of the conventions of two societies that concern themselves with municipal public works—the American Society for Municipal Improvements and the New England Water Works Association.

The former society, although with comparatively small membership, has long exerted a greater influence in improving the character of such works than any other organization, one proof of this being the fact that its street paving specifications have for several years past been the accepted standards.

The N. E. W. W. Association, although sectional in name and origin, has become national to some extent in its membership and to a greater extent in its influence. Its form for reporting water works statistics is more widely used than any other, and its specifications and standards for cast iron pipe were the first to receive general acceptance and use by both superintendents and manufacturers throughout the country.

Many of the members of these societies were unable to attend the conventions (railroad fares are very high these days), and the publication by the societies of the official records of them will probably be postponed for several months. We, therefore, believe that the majority of our readers will welcome a narrative that tells of the most important doings and gives briefly the high points of the facts and opinions brought out in the papers and discussions.

It is not pretended that such a description is a satisfactory substitute for attendance at a convention. Only by being present in person can a member apprehend the mental attitudes of the speakers, which is often necessary for a correct interpretation of their words. Even more important is the mental stimulus to render better service, the renewal of pride in the importance and honor of such service, the broadening of mind and many other benefits to be derived from personal contact with men from all parts of the country who are performing similar work and meeting similar difficulties, and the pleasure of renewal of old friendships and making of new ones. These are things that no printed words can give. We have confined our efforts to recording for the benefit of our readers the bare facts and opinions expressed at the meetings, and hope that they will consider them worth while.

Tests on Tight Sewer Joints

The tests on the use of bituminous material for making water-tight joints between vitrified clay sewer pipes which were described in the September issue are of interest to sanitary engineers, but seem to us to be of little practical value. They demonstrate that joints can be made with this material that will be water-tight under a head of 10 or even 20 pounds pressure. But in order to secure this result the pipe and the oakum packing in the joint must be perfectly dry and the material used for the joint must be at a temperature of more than 350 degrees at the moment of pouring. While the latter condition perhaps is not difficult to secure if a reliable man is in charge of this part of the work, the securing of absolute dryness in a trench the bottom of which is below groundwater level is a condition not so easily maintained continuously throughout the laying of the pipes.

There may be some sewerage systems or sections of systems where an internal pressure of 10 or 15 pounds is exerted against the joints, but ordinarily there is practically no pressure exceeding the few

ounces due to the depth of sewage above the invert of the pipe. What is needed for practical sewer work is not a joint that can be made to withstand 10 or 15 pounds pressure under ideal construction conditions, but one that can be made tight against 10 or 15 ounces pressure when made under the conditions ordinarily encountered in wet trenches.

The tests referred to show plainly that the ordinary cement and sand mortar joint meets all requirements if it can be made under the proper condition and this maintained for 24 hours, this condition being that the cement should remain unmoved in the joint until it is set. The weakness of the cement joint is due to the difficulty of maintaining this condition. Even though the most skillful and conscientious employee be used to make the joint and insure that the mortar is well compacted into and built up around the bottom of the joint as well as the sides and top, if water is allowed to rise onto the joint before the cement is set the mortar will become soft and settle away from the pipe even if it does not entirely slide out of it at the bottom of the joint.

We believe that much tighter joints can be made in sewers with bituminous material properly employed than with cement used under practicable conditions in very wet trenches, but it does not seem to us that the tests above referred to have developed any information which will aid in securing such results.

It seems to us that more profitable experiments would be a series made with a view to developing a procedure for using these bituminous materials or others in a wet trench so as to obtain tightness under 2 or 3 pounds pressure from the inside, or 5 or 10 pounds pressure exerted on the outside of the joint. It is possible, for instance, that instead of oakum which, when once wet, cannot easily be dried, some non-absorptive material could be used to prevent the bituminous material from flowing into the pipe, or some construction of pipe or other procedure be developed which will not require the use of any such material. With the packing dry, it should not be difficult to thoroughly dry the surfaces of the bell and spigot just before pouring the jointing material. An advantage of the bituminous material for joint cement is that it is not injured by water contact once it has been poured into place, and it is therefore necessary to keep water away from the bell for only the two to five minutes required for placing the pipe and pouring the joint.

Reciprocity in Registration of Engineers

The Council of State Boards of Engineering Examiners representing sixteen States met in conference on Oct. 2nd and 3d, and agreed upon rules for the reciprocal registration of professional Engineers. The rules adopted provide that an engineer registered in one State may be permitted to practice in other States that are parties to the reciprocal registration agreement. The articles of agreement will become operative as rapidly as they are signed by the various State Boards and Engineering Examiners. The several State boards are urged to endeavor to have their State laws changed where necessary so as to allow an engineer going into another State to practice under reciprocal registration without the payment of another fee.

The articles of agreement contain a number of specifications as to requirements for registration, included among which are that professional experience shall not be considered to have begun before the applicant has reached his eighteenth year, nor before entering upon a position in professional engineering work that required original thought and responsibility. An applicant for registration must have had ten years of such experience, and, in addition, show that he is qualified to design as well as to direct engineering operations, and "his experience record shall show progressive advancement in the character of the work performed"; graduation from an engineering school being equivalent to four years of such practice.

Certification from one State to another shall be by means of a card or form, bearing date, serial number and signatures of the officers and seal of the Board. An applicant for reciprocal registration must be granted the same if his qualifications fully comply with the standard above described. A reciprocal certificate may be revoked by the State issuing it on "good and sufficient evidence of incompetence, or that the applicant's character warrants such revocation."

Salaries for Sanitary Engineers

In our issue of July 15th, in commenting upon the salaries received by sanitary engineers in the Public Health Service, we stated that after twelve years of service, officers might be promoted to the position of Associate Sanitary Engineer, carrying a minimum salary of $3,920. We have been informed by Isador W. Mendelsohn, assistant sanitary engineer in the P. H. S., that after twelve years promotion may be had to the position of Sanitary Engineer, carrying a minimum salary of $4,550 and a maximum of $5,450.

We are glad to learn that salaries are obtainable more nearly commensurate with the ability and standing that should be required of men filling these important Federal positions. The figures given by us were our understanding of the statements made in the official circular announcing civil service examinations for positions in the P. H. S.

Sewage Treatment for Trenton

The Commission of Trenton, N. J., has adopted a report made by Col. George A. Johnson on the matter of sewage disposal for that city, in which he recommended the installation of a direct oxidation plant with a capacity of thirty million gallons per day, and has directed him to proceed at once with the preparation of plans and specifications. The report was delivered to Trenton on September 19th. It embodies the results of a six weeks' test of the Allentown direct oxidation plant, which is also described by the city engineer, H. F. Bascom, in a paper before the American Society for Municipal Improvements, which we expect to publish next month.

American Society for Municipal Improvements

Narrative of the Convention held in Cleveland October 2nd to 6th; the business transacted and the papers read and the discussion of them

The twenty-eighth annual convention of the American Society for Municipal Improvements, held at the Hollenden Hotel, Cleveland, on October 2nd to 6th, demonstrated the maintained interest in the society which is entertained by the municipal engineers and other officials of this country. Representatives were present from Northern cities extending from Portland, Oregon, to Boston, Massachusetts, and Southern cities from Houston, Texas to St. Petersburgh, Florida. More than 350 registered at the Secretary's office, which indicates an attendance of probably about 400.

One rather unusual and very commendable feature, for which President Rankin deserves credit, was the promptness with which the sessions were begun, and the fact that the printed program was adhered to almost exactly from start to finish In addition to the sessions held for the reading and discussion of technical papers on Tuesday, Wednesday, Thursday and Friday, Monday afternoon and evening were fully occupied by the meetings of a number of the committees, especially those on specifications. During the convention there were presented in a room adjacent to the convention hall a very fine exhibition of materials and appliances used by, or useful for, the public works of municipalities.

There was being held at the same place a convention of the Ohio State Conference on City Planning during Monday and Tuesday, and on Monday and Tuesday evenings joint sessions were held by the two societies.

At the business meeting on Thursday morning Memphis, Tenn., was chosen as the place for the 1923 convention. Invitations had been received from several other places including Montreal, Washington, D. C., and Louisville, the last-named being active with literature in its efforts to secure the next convention. Atlanta, also, sent an invitation, but later withdrew its request for this year, expressing the hope that it would be given favorable consideration for 1924. The committee, in reporting upon the several invitations, gave, as its reason for recommending Memphis, that it seemed desirable to hold next year's convention in the Middle Southwest.

At the same meeting the officers were elected for next year, resulting in the selection of W. W. Horner of St. Louis as President, E. R. Dutton of Minneapolis as First Vice-President, Herman H. Smith of New York City as Second Vice-President, E. L. Dalton of Dallas, Texas, as Third Vice-President, Robert Hoffman of Cleveland as Treasurer, and Charles Carroll Brown of St. Petersburg, Florida, as Secretary.

The only other society business transacted at the meeting was the adoption of amendments to the Constitution at the recommendation of the Executive Committee. It had been generally recognized that a double mistake was involved in including in the present Constitution of the society a long list of fixed committees, both because this list was so long as to be burdensome, and also because it did not seem desirable to have the list included in the Constitution, since it might seem advisable to add new committees, or drop old ones, from time to time. An amendment was adopted by the convention to be sent to letter ballot by the entire membership providing for removing this list from the Constitution and giving to the Executive Committee the power to determine what committees should be appointed from year to year.

Another constitutional amendment was one providing that engineers of public utilities should be eligible for active membership in the society. In the past it has been necessary by the Constitution to admit them only as affiliated or associate members. These two amendments will, as required by the Constitution, be submitted to the entire membership during the coming year.

TUESDAY'S SESSIONS

The convention was formally opened at 10 A.M. Tuesday, by an address of welcome delivered by Ray Miller, representing Mayor Fred Kohler, and responses by the President of the Ohio State Conference on City Planning and by W. W. Horner, First Vice-President of the A. S. M. I. This was followed by a brief address by Robert Hoffman, Chairman of the Convention Committee.

Edward S. Rankin, President of the society, then delivered his annual address. The President touched upon the advantage to the society of having in its membership officials other than city engineers; the desirability of higher salaries for city engineers; the desirability of having more contractors among the associate members, together with the advantage of retaining in such membership the material men, so-called; making a plea for co-operation between the engineer, the material man and the contractor in securing the best possible results in municipal public works. He suggested that the four points

of the star which forms the design of the society's pin, represented the four elements of membership—the municipal executives, the engineers, the contractors and the manufacturers.

Following the President's address, the Executive Committee reported, the principal features of this being the recommendation that the society adopt the constitutional amendments already described.

The Secretary rendered his report for the year, showing the membership changes and the accounting for cash received by him. The active membership during the year showed a net increase of seventeen, with 500 members on August 31, 1922. The affiliated membership showed a loss of three, with thirty-two members at the date named, while associate membership showed a net gain of one, being 131 at the end of the year; giving a total of 663 members on August 31, 1922. The finances, since the convention was earlier this year than last, covered a period of only eleven months, which showed its effect in somewhat smaller receipts; in addition to which the fact that the misfortunes of the firm that printed the Proceedings had so greatly delayed their appearance that the collections for the advertising therein had not all come in. Membership dues for the eleven months totalled $3,508; from Proceedings sold, $144.55; from Specifications sold, $8.25; from advertisements in Proceedings, $423.81; from miscellaneous, $1.82; giving a total remitted to the Treasurer of $4,086.43. In round numbers, the expenditures totalled $940 for office and miscellaneous, $1,067 for convention expenses, $1,210 for the 1920 and 1921 Proceedings, $192 for printing Specifications, $85 for letter ballots, $300 for Secretary's salary, $360 for committee expenses, and $29 for clearing house expenses. The Secretary reported that the delay in printing the Proceedings was explained by the printer as due to a storm which destroyed the wires through which he obtained power for his plant (which is located in a small town) and a subsequent epidemic which practically closed his printing house; although even with these handicaps there seemed no excuse for his not finishing the work two or three months earlier than he did. Arrangements have been made with another printer for this year's Proceedings, and he promises to place upon the shoulders of the Secretary any blame for delay in getting them out.

At this meeting a Committee on Nominations was appointed consisting of Messrs. Tillson, Howell, Pierson and Kingsley; Committee on Place of Meeting, consisting of Messrs. Compton, Corson, Barnes, Near and Kingsley; and a Committee on Resolutions, consisting of Messrs. Hatton, Conant, Pollock, Reimer and Sprague.

The usual gathering of a large percentage of the Past Presidents of the society, which has been one of the remarkable features of this association at every convention, lacked one of its faithful attendants—ex-President Fred Giddings, whose health did not permit his attending, and the society sent him a telegram of greetings.

The report of the Committee on Fire Prevention, presented by Alcide Chausse, had been printed in the advance papers, and was read by title. A paper which it had been intended to present on Thursday describing the Selo Process of Sewage Treatment, was read by the Secretary, this being one of only two changes in the program.

On Tuesday afternoon A. V. Ruggles, Commissioner of Water of Cleveland, gave a brief description of the Cleveland water supply. Owing to the considerable elevation of parts of the city, the distribution system has been divided into a low service and a first, second, and third high service, the last serving elevations some of which extend to 800 ft. above the lake, and the second high service serving those between 250 and 500 ft. At five points the water mains are carried under the river in tunnels, while at a sixth the main crosses the river but not in tunnel. The supply is obtained from the lake through two inlets. That received through the west side tunnel is filtered. That through the east side tunnel is not filtered but is treated with chlorine, but a filter at this point is now under construction. The water works system serves an area of about 475 square miles, in which it is estimated that there will be a population of one million six thousand people by 1940. The consumption at the present time is about 135 gallons per cap. per day, about 60 per cent. of which is industrial.

In the absence of the Chairman, the report of the Committee on Municipal Legislation and Finance was read by the Secretary of the society. This report gave a resume of changes during the past year, prominent among which were the additional financial difficulties thrown upon the cities. Increased pay to the police and fire departments was accountable for a considerable part of this. This increased expenditure resulted in corresponding increases in the tax rates and in assessment valuations. A number of cities have provided additional sources of revenue, including new classes of permits and of taxes, such as automobile fees, taxes on gasoline and sign boards, a more general assessment against abutting property for public improvements, etc. There was also evident a commendable effort toward increased economy, a number of cities have established purchasing departments with this end in view. In the matter of legislation the committee called attention to the growth of the idea of Home Rule for Cities, reducing the number of officials, direct primaries, non-partisan ballots, etc. The rapidly increasing popularity of city planning also was referred to.

Dr. A. R. Hatton then read a paper entitled "Should Municipal Administration Be Professionalized?" in which he strongly emphasized his belief that every man from the bottom to the top in every branch of municipal administration should have been professionally trained for the municipal work in which he is engaged. Even a training along the same general line is not sufficient; bankers, for instance, being frequently very poor advisers on public finance, which is an

entirely separate branch of business. This paper was discussed by Messrs. Lewis and Durham who brought out some further explanations of the author's opinion.

The report of the Committee on Water Works and Water Supply had been published in the advance papers and was down for a discussion at this session, but in the absence of Mr. Fuller, the Chairman, the discussion was postponed until a later session. The session closed with a paper on athletic fields and stadiums by Arthur Leland, of the Committee on Park Systems and Open Spaces. In this he gave a large amount of exact data concerning dimensions and other requirements for baseball diamonds, football grounds, soccer, lawn hockey, lacrosse, tennis, golf, quoits, coasting and other sports.

The evening session, which was held jointly with the Ohio State Planning Conference, was opened with a report by Nelson P. Lewis as Chairman of the Committee on City Planning, this report being in the form of a paper on regional planning. After giving some facts concerning regional planning as adopted or under consideration by different cities and districts, Mr. Lewis described the work being done by a committee which is supported by the Russell Sage Foundation in preparing the greatest regional plan ever considered—that being made for New York City and adjacent area in three States, covering about 5,500 square miles. This explanation was made more interesting and intelligent by the free use of lantern slides showing maps and diagrams which presented clearly the exhaustive studies which the committee had made into every phase of commercial, industrial, and social life affecting the problem, geography, topography, transportation, and the many ramifications of the subject.

Following this a description was given by a representative of The Fairchild Aerial Camera Corporation of the work which it does in making aerial surveys. A number of photographs taken by this company had been shown by Mr. Lewis in order to give more clearly in a few general views an intelligent idea of the territory covered by the New York regional plan. The photographs shown could be generally classed as bird's-eye views and scale maps, the latter being taken vertically and at a uniform elevation so that they represented an exact scale. For instance, several dozen such maps were shown fitted together so as to form a map of Manhattan Island, New York, on which could be seen every building and even the traffic moving in the streets, all to an exact scale.

A paper on Control of Property Sub-divisions was read by E. A. Fisher, Superintendent of City Planning of Rochester, and one on the Treatment of Intersections of Heavily Travelled Traffic Arteries, by Clarence Farrier, was read by the Secretary; and a report of progress was presented by J. M. Rice as Chairman of the Subcommittee on Park Systems and Open Spaces. A discussion of these three papers was taken part in by Mr. Wynne-Roberts of Toronto, and others; following which G. J. Requardt of Baltimore read a paper discussing the treatment of garages in the various zoning ordinances adopted, in which he called attention to certain restrictions to public garages and definitions of the distinction between public and private garages which seemed to demonstrate the necessity for some modifications of these features of zoning ordinance, which paper was discussed by J. C. Grennalds of Baltimore.

WEDNESDAY'S SESSIONS

On Wednesday morning W. A. Howell, Chairman of the Sub-committee on Street Paving, presented the roport of that committee reviewing the progress of paving matters during the past year. While the outlook for paving had been good early in the year, by June 1st rising prices had made it dubious, causing postponments of many projected works, especially those for the laying of granite block pavements, the cost of the blocks being held too high to warrant general use. In spite of this, the record for the first eight months of 1922 indicates an amount of paving work 50 per cent. in excess for that for the same period of 1921 on the basis of amount of money spent.

This was followed by a paper by Clarence D. Pollock entitled, "Value of Present Tests for Granite in Determining the Probable Wear in Pavements." (This paper is published elsewhere in this issue.) In discussing this paper, Mr. Norton expressed his doubt of the value of a high coefficient of wear in a stone block pavement, believing that some wear is desirable in order to secure and retain a smooth surface, while the increasing scarcity of horse-drawn traffic is rapidly eliminating the necessity for toughness or hardness in paving block material. Mr. Pollock, however, replied that he had found, where bituminous mastic is used as filler and squegeed over the pavement, that it adhered to the low points for seven or eight years, and that even hard granite wears down on the high points under rubber tires even more than it did under steel tires because of the abrasion caused by the driving wheels of motor-driven traffic. Mr. Durham expressed the opinion that inspection and good laying were more important than testing. Mr. Sprague stated that with automobile traffic the objection to smooth pavements on steep grades had largely disappeared, but Mr. Norton maintained that they still presented a serious danger of skidding, especially when wet leaves were present.

The report of the Sub-Committee on Sidewalks and Street Design was read by E. R. Conant, the Chairman. Mr. Conant presented a very complete discussion of the several elements of sidewalks and streets, and gave a series of general recommendations for the preparing of designs. Considerable discussion followed this paper, dealing with several of the many points brought up. Mr. Pollock suggested that in the planting areas provided in the street plan, maintenance should be by the city in order to secure and

maintain a good appearance. Mr. Folwell stated that a number of cities were omitting catch basins at storm water inlets and that they should in this question be considered as special construction, rather than uniform practice, the majority of basins in large cities never being cleaned and, therefore, being worse than useless. One member stated that they were being omitted in many localities because of the danger of mosquitoes breeding in them, and Mr. Durham stated that in Panama, where the elimination of mosquito-breeding was such an important matter, no catch basins had been allowed or in use for fifteen years, although the sewers were on the combined system, and that no nuisance had resulted. Mr. Rankin stated that the city of Newark, N. J., was considering the elimination of catch basins, while another member stated that in St. Louis, where inlets had been built without catch basins, such basins were being constructed for about 3 per cent. of them.

Concerning the matter of corner radii, Mr. Conant, in reply to a question, referred to an example of curb corners which were given a 30-foot radius, but this radius compounded into sharp curves at each end, the flat radius thus approximately paralleling the travel of a truck with long wheel-base which, as was the general practice, swung out into the center of the street before turning the corner, and one or two members commented favorably upon this idea. Mr. Corson stated that Morristown found 15-foot corner radii satisfactory. Mr. Langgaard, city engineer of Portland, Ore., stated that in some of the outlying sections streets twenty to twenty-four feet wide were being built with concrete pavements, the inlets being in the center of the street. Commenting on this, Mr. Rankin stated that in Newark, where, as in most cities, the alleys are made concrete, manhole covers in the alleys are used as inlets for storm water. In the matter of alleys, Mr. Brown stated that nothing smaller than a 16-foot alley was of any practical use, since if narrower than this it was very difficult for a vehicle to enter or leave it from an intersecting street, while with less width the passing of vehicles in the alley was impossible.

"The Cleaning of Streets and Highways" was the subject of a paper by G. A. Crayton, State Highway Engineer of South Dakota, which was read by the Secretary. In this paper Mr. Crayton discussed the theoretical cross-section which would secure a uniform velocity of flow of rain water in reaching the gutter, which would result in two concave surfaces intersecting at the center of the street. This would be impracticable, but he suggested a compromise between this and the ordinary convex surface, or two planes intersecting at the center.

George H. Norton, Chairman of the Sub-Committee on Street Maintenance, in presenting the report of that committee stated that it had nothing new to report, but urged a further discussion on the subject of relation between original construction and maintenance, and especially, a discussion of the paper presented by Mr. Norton at last year's convention under the title "The Economical Extent of Pavement Repairs and Maintenance."

The Chairman of the Sub-Committee on Street Railway Construction, Henry Maetzel, has been ill for some time and was not present, but reported progress through the Secretary. Papers on "Bituminous Surfaced Gravel for Light Traffic Streets," by D. B. Davis, and "Building Gravel Roads with Bituminous Surfaces," by Philip P. Sharples, had been printed in the advance papers and were read by title and no discussion offered.

As there was some time remaining before adjournment was necessary, the President asked if there were any questions the members would like to discuss, and the "Backfilling of Trenches" was suggested. Mr. Norton stated that in Buffalo clay trenches were replaced by thorough ramming of the clay, when damp but not wet, or else replacing with cinders. The latter was almost as cheap as thorough compacting of the clay. Mr. Pollock referred to the mixing of cement with the dirt in the top foot or two of the backfilling. Mr. Corson reported the practice of replacing pavement foundations over trenches by arching the concrete. Mr. Norton expressed the belief that placing a concrete arch over a trench was not to be recommended, since if the trench settled, the arch was sure to settle sooner or later, and sooner was preferable as it then allowed the placing of the responsibility upon the proper parties. E. R. Gray said that in Hamilton, Canada, the property owner is given twenty days after notice to put in house connections including those for vacant lots. The result of all connections in the street being put in at once is a very badly cut-up condition. In paving over these trenches, wire mesh was used in the concrete, preceded by a thorough tamping of the trench. He advocated allowing the trenches to settle one year before paving. Mr. Norton stated that in Buffalo property owners arranged with the street paving contractor for putting in any house connections needed, before the pavement is laid, and the paving contractor is then held responsible for the pavement, whatever happens. The work was generally done by plumbers under sub-contract with the contractor, who held these plumbers responsible for any subsequent settlement of the pavement. E. R. Kinsey, of St. Louis, expressed the opinion that a growing city must always expect to have cuts made in its pavement. Mr. Dillon referred to Hamburg, Germany, where, in the case of wide streets, all conduits for local use are placed in the sidewalk area. Mr. Dutton said that in Minneapolis it is impossible to get the soil back so it will not settle. The city ordinance prohibits any cutting of the pavement for two years after it is built, but so many exceptions are obtained, some of them by political pull, that the rule is not generally observed. Mr. Norton suggested a charge of $25 to $50 for permit to cut the pavement during the first year after construction, and a reduction in the charge for each succeeding year, believing that there was a legally defensible

Fuel Oil in Harbors

[illegible]

N. E. W .W. Convention

Papers and discussions at the September convention of the New England Water Works Association

The Annual Convention of the New England Water Works' Association was held at New Bedford, Mass., on Sept. 12th to 15th. It was a successful convention, the program well-balanced between technical discussions, inspection of engineering works, and entertainment and social features. The only untoward event was a rainstorm which drenched a number of those who were inspecting the water works properties of the City on the first day of the Convention.

The total attendance registered with the Secretary was about 450, of which about 160 were active members. The meetings were well-attended, ordinarily about 100 to 125 being present shortly after the opening of each session. The Program Committee had left abundant time for discussion of the papers, so that it was not necessary to cut short the discussions at any point. As much discussion did not materialize as there was time for and as might have been profitable, and most of the sessions adjourned because of the conclusion of the program and discussions rather than from pressure of time.

The exhibition was located adjacent to the Convention Hall, and was very attractive, there being about 45 exhibitors.

The program Tuesday opened with the address of welcome by Mayor W. H. B. Remington, following which was the description of the New Bedford Water Works by the Superintendent, Stephen H. Taylor, who also described some experiments with substitutes for lead in jointing cast iron pipe; these being preliminary to the automobile ride in the afternoon to the Quittacus pumping station, the reservoir and other parts of the system, and an exhibition of the laying of iron pipe with leadite. The speed of laying this pipe was favorably commented on by the superintendents, who were assured that it was no greater than ordinary every day practice with the Water Department, except that, possibly, a greater length of trench than ordinary was open; trench excavation being, in fact, the only limitation so far encountered to the speed in pipe laying. The evening of Tuesday was the occasion of an informal reception and dance at the Hotel.

WEDNESDAY'S SESSIONS

Wednesday morning opened with a paper by David A. Heffernan, superintendent of the water works of Milton, Mass., who discussed the relation between quality of water and the duration of service pipes. He stated that investigation in his City had, apparently, proved that galvanic action was caused by current from the grounding of house wiring by attachment to the water pipes, the action entirely ceasing when the wires were removed. A method of preventing this adopted in Milton was to attach the ground wire between the cellar wall and the meter and insert an insulation in the pipe on the house side of the point of attaching the wire. In the discussion several members raised a question as to the possibility of galvanic action resulting from the grounding of wires of a system carrying only alternating current, Mr. Kemble stating that experts have advised making such connections, and that this advice was also given by a committee of the American Water Works' Association appointed to report on the subject; but Mr. Heffernan stated that investigation by experts in his city had proved the facts as stated by him.

Later in the discussion, Mr. Heffernan stated that he did not think check valves should be allowed on service pipes in connection with pressure boilers, as they might be the cause of explosions, and in this opinion he was supported by other members. In connection with damages for collapsed boilers due to any responsibility of the Water Works Department therefor, Secretary Gifford stated that Boston pays for collapsed boilers, following a decision of the Superior Court that the city was responsible. At the conclusion of the discussion it was voted that the President appoint a Committee to study the general subject of "Currents in House Plumbing."

The subject of the removal of gas and odors and prevention of corrosion having been raised by Mr. Heffernan, George W. Fuller was asked to give some information on the subject, and stated that the former could generally be effected by the use of filtration and aeration, and that corrosive properties of the water also were largely removed by aeration. In Memphis the Water Department is confronted with the problem of rendering suitable a water carrying from 85 to 120 parts of CO_2, and the treatment that will probably be used is aeration and the addition of lime.

The next paper was one entitled, "Co-operation," by Francis T. Kemble, secretary of the New Rochelle Water Company. The principal point made by Mr. Kemble was the importance of getting the employees to put their heart into the work they did for the water department or company, this being worth more in results obtained than either ability, or experience. He stated that he keeps his gang all winter, finding work of some kind or other for them to do. Mr. Saville also stated that he keeps a large gang through the winter on forestry and other work. Another member, however, stated that he found it impossible to keep more than a small part of his men through the winter, and believed that it was necessary to adopt labor-saving machin-

ery to solve the labor problem. Mr. Little reported finding it difficult to get energetic men for digging, but Mr. Saville said that he does not try to obtain young men for this, as they are difficult to keep, but uses the old men who have been with the department for many years and are experienced and reliable. He suggested a system of pensions as desirable to encourage the men to remain with the department, and Mr. Gear cited the state law for pensions in Massachusetts, which retires laborers at half pay at 65 years. Mr. Taylor stated that he found Portuguese labor to be better than Italian.

Thos. E. Lally, assistant engineer with the Public Works Department of Boston, read a paper on the "Inspection of Water Works Equipment." He described a number of the details of inspection, as well as its advantages and necessity; for instance, he stated that Boston has long used wicking boiled in tallow as packing for the stuffing boxes of valves.

In the afternoon Percy R. Sanders read a paper entitled, "Pumping by Electricity at Concord, New Hampshire." This paper will be published in "PUBLIC WORKS." By the change from steam to electricity the city saves entirely the salary of a fireman. The same engineer still operates the plant. During the two-and-a-half years that the pump has been in service there has been no shutdown from electric trouble. Mr. Diven and others told of experiences with centrifugal and volute pumps, one of the latter types operated by the Public Service of New Jersey having shown an efficiency of 80%.

"Experiences with a Thirty-Five-Year-Old Steam Pump" were narrated by Fred O. Stevens, this pump being a duplex, compound steam pump of 1½ million gallons' capacity which had operated twenty-nine years at full overload and six years at normal load. In 1920 one of the cylinders cracked and was repaired and an electric centrifugal was installed as quickly as possible because it could be obtained sooner than a steam pump. Later, cracks developed in both suction chambers, and these were repaired with hot asphalt applied on the outside, the pump being turned over slowly meantime so as to draw the asphalt into the crack. This served the purpose quite successfully until the plant had been reinforced so as to permit the permanent repair of the pump.

George A. King, superintendent of the Taunton Water Works, started a discussion as to whether the water department should be merged with other municipal departments in its management and finances. The members seemed to be more or less divided on the subject, although the majority of the superintendents present appeared to be strongly in favor of absolute independence for the Water Department. Mr. Sherman expressed the opinion that while, in a large city, a good man could be provided for each department and thus independence with efficiency was practicable, in the small city if several departments were merged, as into a department of public works, there would be one man in charge of several departments who might be an expert in one line only, which line would probably not be water, and he therefore thought that independence was especially important for small cities. M. N. Baker, however, believed that, because it was difficult for a small city to employ an expert for each of the departments, the efficiency of the water department, as well as of the other departments, would probably be greater with the departments merged and placed under the head of an efficient man, rather than having a low-salaried man for each department. Messrs. Simonds, Thomas, Diven, Gifford and others joined in the discussion, at the conclusion of which it was voted that three Massachusetts members be appointed to take up with the Massachusetts Legislature the subject of merging the water department with other departments in management and finances, this subject being one which the Legislature was expected to consider before long.

There still remaining considerable time before adjournment time and this being Superintendents' Day, the meeting was opened for questions. One member asked whether any cities had high and low service systems with an electrically operated gate between them, and two or three members told of services connected in somewhat this manner, although not quite the same. Another member introduced the question as to who should be allowed to operate fire hydrants. Two or three members stated that in their cities the Moth Department was the largest user of water, and there seemed to be an opinion that that department should be permitted to use the fire hydrants without special permits for each occasion.

In the evening Caleb M. Saville discussed the subject of "Cross Connections for Private Fire Protection." From experiences Mr. Saville had reached the conclusion that even a double check did not offer perfect security, and in this he was supported by a number of members. Mr. Winslow told of an instance where both checks were held open by a pair of overalls a little longer than the distance between the valves. The double check was defended by a representative of the fire insurance companies in a prepared discussion. One of the members stated that the Factory Mutual was practically alone in strongly advocating the double check. Mr. Diven advocated two entirely unconnected supplies where the factory thought it necessary to have its private supply for fire purposes.

THURSDAY'S SESSIONS

On Thursday morning, after electing seven new members (thirteen had been admitted on Wednesday morning), the Joint Committee on Meter Specifications, which co-operated with a similar committee of the American Water Works' Association, stated that the joint report had now been brought to the point where it could be put in formal shape for consideration at the winter meeting of each of these societies.

F. X. Goodnough, chief engineer of the Massachusetts Department of Health, described "The Water Supplies of Southeastern Massachusetts." As Fall River and New Bedford together contain more than 80% of the population

of this section of the State, the discussion was confined largely to the consideration of the water supply of those cities. Fall River is now using all the water available from North Pond, while South Pond is smaller and the water is grossly polluted and, in addition, is needed for the mechanical purposes of the mills of the city. There seemed no question but that the city must ultimately go to the Lakeville Ponds, several miles to the northeast. New Bedford, by metering, had kept the consumption down to 83 gallons per capita, but is now using 80% of the safe yield, and, if its growth continues, will also need before long to obtain water from the Lakeville Ponds. Taunton, the next largest city in the district, obtains its supply from these ponds, but does not need the full amount that it controls. The time was rapidly approaching, therefore, when these cities, with the State Board possibly serving as advisor and arbitrator, would have to come to some agreement on the use of the water from these ponds.

Following the reading of this paper by Mr. Goodnough, he was notified by Mr. Weston, for the Committee on the Award of the Bracket Medal, that the Medal for last year had been awarded to him.

H. K. Barrows, of Boston, then described the water supply of Fall River, bringing up to date a description of the same supply which he had presented to the society several years ago, and supplementing the brief description of the supply given in Mr. Goodnough's paper. In view of the fact that Fall River, New Bedford and Taunton were not in accord in the matter of the Lakeville Ponds, each, naturally, viewing the matter from its own standpoint and desiring to control as much as possible of this water, some of the members had expected the discussion of these two papers to be quite peppery, but, as a matter of fact, nothing but technical principles and good nature prevailed.

The last paper of the evening was a description of the "New Water Supply of Providence" by Frank E. Winsor, chief engineer of the Water Supply Board. The construction details of the new water supply were described in last month's issue of "PUBLIC WORKS."

The afternoon session opened with a renewal of the discussion on the double check valve. During the discussion Mr. Saville expressed his opinion that the only advantage of the double check is its cheapness. In Hartford it is permitted to discharge the city supply into a tank, the outlet of the supply pipe to be above the level of the tank, which tank should then connect with the factory's private supply. This method was believed to be safe, but would cost a little more than a double check.

"A New Method of Purifying Water" was then described by Harry W. Clark, chief chemist of the Massachusetts Department of Health, the method consisting of the use of slow sand filters treated with aluminum hydroxide. This paper will be published in "PUBLIC WORKS." This method was said to cut the cost of precipitant from the five to six dollars per million gallons required for rapid sand filters to fifty-five cents per million gallons, or less. In answer to a question, Mr. Clark stated that the hydrogen-ion value was increased by this treatment. He also stated that hydroxide precipitated slowly as the water containing the solution was held in the filter and the precipitate coated the individual sand grains.

Thursday afternoon those attending the Convention were taken by steamer around Buzzard's Bay and by trolley to Fort Phoenix, where a clambake was served.

FRIDAY'S SESSIONS

Friday morning was devoted to papers on use of water for fire protection, Frank A. McInnes, engineer of the Water Division of Boston, describing the Boston high pressure service; George W. Booth, chief engineer of the Board of Fire Underwriters of New York, discussing "High Pressure Fire Systems from the Underwriters' Viewpoint"; which papers were followed by statements from fire chiefs on the "Value of High Pressure Service from the Fire-Fighters' Viewpoint." Mr. Booth, using as an illustration some of the big fires in New York City, showed that with high pressure, fewer companies would be required for fires that called for large quantities of water. In one fire in New York this year more than 30,000 gallons per minute were being discharged at a pressure of over 200 lbs. at the hydrant, which would have required the service of sixty fire companies if fire engines had been used. Mr. McInnes stated that the Boston High Pressure System, as proposed, will protect about one square mile, which includes practically the entire congested value district. There will be eight pumping units in three separate stations. Two of these stations feeding 313 hydrants have been in service for eight months. For joining the pipes in the distribution system an alloy of 95% lead and 5% tin is used, and two lead grooves are cast in the bell end and spigot end of each pipe. Tests showed that the addition of the tin made the joints sufficiently strong to permit dispensing with tie rods. The tin is added to the hot lead at the last minute just before pouring. Calking is done with dog tools, using a two-handed 4-lb. hammer, and is finished or polished off with hand tools.

In the afternoon E. Sherman Chase read a paper entitled, "Sanitary Dangers to Water Supplies"; J. E. Garratt, office engineer of the Hartford Water Board, described the "Application of Copper Sulphate to the Hartford Reservoirs and Some Effects on Length of Filter Runs," and Robert Spurr Weston gave an "Elementary Discussion of the Hydrogen-ion Determination and Its Significance." Mr. Garratt's paper was a description of the experiences of Hartford, and some questions concerning the details of the use of copper sulphate raised by these experiences. One tentative conclusion reached was that the application of copper sulphate has possibilities as an aid to economical filter operation, at least with Hartford's water.

Rental of Contractor's Equipment

Form of agreement adopted by Associated General Contractors for use in renting such equipment. Conditions of lease set forth plainly and fully.

The Executive Board of the Associated General Contractors has adopted an equipment rental agreement as a standard for use by contractors, which has been developed after two years' study and criticism by association members. It is based upon the premise that a contractor will be willing under this form to assume the obligation of either the lessee or lessor. Its object is to establish on a basis of common equity those obligations and responsibilities properly involved in renting construction machines and to provide a simplified rental agreement which will insure absolute fairness to both parties.

Misunderstanding has frequently arisen in the past when equipment was rented by either verbal or written agreements or by an unsuitable form of lease. It was thought that the misunderstandings and inequities resulting from such conditions could be avoided in most cases if there was a standard form of lease which could be filled out easily or accepted by wire or otherwise for later official signing.

The standard form is arranged so that all blank spaces for filling in of dates, rental rates and other stipulations are segregated on the front of a single sheet, while those provisions of general application and requiring no filling in for ordinary conditions are segregated on the back. Copies of the form can be obtained from the Associated General Contractors of America.

The front page of the lease provides for filling in the date, the names of the parties, the point at which the equipment is furnished f. o. b., a description of the equipment, the place at which it is to be used, the approximate rental period, manufacturer's shop number, the lessor's identification number, the value of the equipment, and the rental rate per article. This is followed by the signatures of lessee and lessor and two witnesses. The general conditions of the lease are as follows:

The conditions of lease here below stated, together with the Agreement set forth on the reverse side of this sheet, constitute between the parties therein named a contract which is hereafter referred to as this Agreement.

1. The Rental Period. The Rental Period shall begin on and include the date of either legal delivery of the equipment to the Lessee or his agent, or legal delivery to a public carrier for transit to the Lessee; and shall end on and include the date of either legal delivery of the equipment to the Lessor, another lessee or an agent of either, or legal delivery to a public carrier for transit to the Lessor or another lessee.

2. Determination of Rental Charges. The Lessee shall pay rental for the entire Rental Period on each article of equipment named in the List of Equipment, at the rate therein stipulated and in accordance with the following:

(a) Monthly Rental Rates shall not be subject to any deductions on account of any non-working time in the month, but the amount of rent payable for any fraction of a month at the beginning or end of the Rental Period shall be the monthly rental rate, prorated according to the number of calendar days in such fraction.

(b) Daily Rental Rates shall not be subject to deductions for any non-working time in the day and shall be paid for each calendar day in the month except Sundays and legal holidays upon which the equipment is not operated.

Daily and monthly rental rates stipulated in the List of Equipment contemplate an operating day of ten (10) hours, and for each hour over ten that the equipment is regularly operated these rates shall be increased four (4) per cent throughout such period as the equipment is so operated.

(c) Unit of Work Rates shall be paid for each unit of work in which the equipment participates, and the amount of rental shall, unless otherwise agreed in writing, be determined by the number of units shown in the supervising engineer's or architect's estimates.

3. Payment. The Lessee shall pay to the Lessor as the minimum amount due under this Agreement, two (2) per cent of the value as shown under List of Equipment of each article of equipment, and shall pay as the minimum rental on each such article, loaded for transit to the Lessee, four (4) per cent of such value.

The amount of rental accruing each month shall be paid on or before the fifteenth of the following month at the office of the Lessor or such other place as may be mutually agreed upon.

Deferred payments shall bear interest at seven (7) per cent, but the payment of this interest shall not waive the Lessor's right as hereinafter stipulated to terminate this Agreement.

4. Loading, Unloading and Transportation. The Lessor, at his own expense, shall load the equipment for transit to the Lessee and upon its return unload it, and shall pay all demurrage charges accruing at his own shipping or receiving point. The Lessee, at his own expense, shall do all other loading, unloading, installing, dismantling, and hauling, and shall pay all demurrage accruing at his own shipping or receiving point, and all freight and switching charges.

The Lessor may ship the equipment in accordance with his own judgment if shipping instructions are not furnished within seven (7) days from date of this Agreement.

5. Recalling and Returning Equipment. The Lessor may recall any or all equipment upon thirty (30) days' written notice to the Lessee and the Lessee may return any or all equipment upon a like notice to the Lessor.

6. Maintenance and Operation. The Lessee shall not remove, alter, disfigure or cover up any numbering, lettering or insignia displayed upon the equipment, and shall see that the equipment is not subjected to careless or needlessly rough usage; and he shall at his own expense maintain the equipment and its appurtenances in good repair and operative condition, and in such condition return it to the Lessor.

7. Supplying Operators. Unless otherwise mutually agreed in writing the Lessee shall supply and pay all operators employed on the equipment during the Rental Period, and shall employ none thereon who are incompetent to perform their respective duties. Should the Lessor, by agreement, furnish any operators, each shall receive from the Lessee such traveling expenses, board, lodging, and wages as the Lessee and the Lessor may agree upon in writing.

8. Damage to Equipment. The Lessee shall indemnify the Lessor against all loss and damage to equipment during the Rental Period and the appraisal of any such loss or damage shall be based on the equipment values shown by the List of Equipment. Any shortage or damage claim of either party shall be made known to the other party within seven (7) days after receipt of equipment, or such claim shall be void.

9. Repairs. The Lessees shall pay the cost of re-

rolling old boiler tubes and of all other repairs and renewals, except that if, in any calendar month, more than seven (7) per cent of the total number of such tubes should, under reasonable care, require replacement, the direct labor and material cost thereof over and above that of the seven per cent shall be borne by the Lessor.

10. Liability of Lessee. The Lessee shall indemnify the Lessor against all loss, damage, expense and penalty arising from any action on account of personal injury or damage to property occasioned by the operation, handling or transportation of any equipment during the Rental Period.

11. Inspection. Before the equipment is loaded for transit to the Lessee, he may require an inspection thereof by proper authorities, and if the equipment is not in substantially the condition required by this Agreement the cost of inspection shall be paid by the Lessor.

The Lessor shall have the right at any time to enter the premises occupied by the equipment and shall be given free access thereto and afforded necessary facilities for the purpose of inspection.

12. Title. Title to the equipment shall at all times vest in the Lessor unless transferred to the Lessee through sale. The Lessee shall give the Lessor immediate notice in case any equipment is levied upon or from any cause becomes liable to seizure.

13. Termination of Agreement. Should the Lessee defer any payment more than thirty (30) days, or become bankrupt, or fail to maintain and operate or to return the equipment as provided by this Agreement, or substantially violate any provision thereof, the Lessor may, after three days' notice, terminate this Agreement, take possession of the equipment without becoming liable for trespass, and recover all rental due, full damages for any injury to, and all expense incurred in returning the equipment.

Should the Lessor fail to ship the equipment in substantially the condition stipulated by this Agreement, or within ten (10) days from date thereof, or substantially violate any provision thereof, the Lessee may, upon three (3) days' notice, terminate this Agreement, recover all sums paid the Lessor, and in case of shipment not in operative condition as specified may return the equipment at the Lessor's expense.

14. Insurance. The Lessee shall, at his own expense, maintain fire and other insurance, if requested by the Lessor.

15. Bond. The Lessee shall, if requested by the Lessor, furnish a bond in amount of the value of the equipment as shown by the List of Equipment, and with the sureties satisfactory to the Lessor, to insure fulfillment of this Agreement.

16. Sub-Letting. No equipment shall be sub-let by the Lessee, nor shall he assign or transfer any interests in this Agreement without written consent of the Lessor.

17. Purchase of Equipment. Should the total continuous rental paid by the Lessee for any units of equipment amount to one hundred and fifty per cent (150%) of the value thereof as shown by the List of Equipment, no further rental shall be paid on such units and the title thereof shall vest in the Lessee, and he shall have the right at any time upon thirty (30) days' notice to purchase any equipment by paying the difference between the total continuous rental already paid and one hundred and fifty per cent (150%) of the value—payment of such difference to be made upon such terms as the two parties may decide.

Fair Allowance for Force Account Work

The "Members' News Letter" of the Associated General Contractors discusses editorially the question of what is a fair percentage allowance over net costs to provide for incidentals in connection with force account work where the cost of labor and insurance only is allowed. In a contract between a member of the Association and the chief engineer of a Flood Control Board it is provided that the contractor realize a 15% profit, and the determination of the allowance necessary to insure this has been left to the Associated General Contractors for decision.

The contract is for the construction of a dam in which, owing to indefinite foundation formations, the work involves considerable force account work which is to be paid for by the Flood Control Board, including all necessary expense connected with it.

It has been common practice to allow a contractor a carrying charge to cover the cost of maintenance of men, including such details as loss on boarding houses, cots, mattresses, tent depreciation, water supplies, transportation, etc. The work is located 25 miles from town on the desert where the water supply is very costly.

The preliminary opinion of the A. G. C. is based on the assumption that the work being done on the main contract is small in comparison with the force account work on the foundation, and that under these conditions the fair and usual procedure would be to divide the field overhead expense in relation to volume of contract work and of force account work as indicated by the payroll. If the payroll was running $3,000 a week and $1,000 was indirect expense and the balance was proportioned equally between contract and force account work, the fair and equitable distribution then would be 50% of the overhead on the force account work and 50% for contract work.

It is assumed that the camp outfit would last only the life of the job, assumed to be one year, and that for the plant 4% per month of original cost should be charged for use and depreciation. From the incomplete information at hand it was concluded that the actual cost of overhead and indirect expenses would be from 15% to 20% of the direct labor and material costs.

Testing Bridge Foundations

Engineers of the State Highway Commission of North Carolina have profited by experience in the past in their own state and in others where too little attention has been paid to the foundation of bridges and many otherwise substantial structures have been destroyed because of this. In the July issue of the North Carolina Highway Bulletin, the monthly publication of the State Highway Commission, P. K. Schuyler describes the method now employed by the Commission through its Bridge Department in determining the character of foundations upon which its bridges are to be built.

There are five general methods employed—the open pit method, the use of sounding rod, of an earth auger, by wash borings, and by diamond drill borings.

The open pit method consists of digging a hole in the ground, but the labor and expense involved is considerable if carried to any appreciable depth. The sounding rod method is fairly satisfactory for a depth of 15 to 20 feet, but it is almost impossible to determine by its use whether it has struck a layer of rock or hard

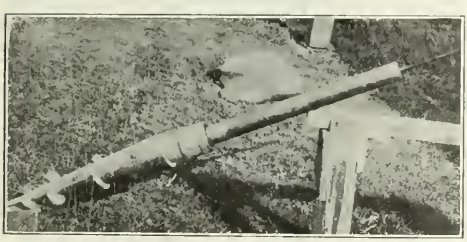
gravel. The earth auger is very satisfactory and economical up to a depth of 20 feet under certain conditions. Samples of the material encountered may be brought up for examination and solid rock may be determined by the clear ring which is given off when the auger is dropped. The earth auger and the wash boring methods are perhaps the most satisfactory and generally used. The diamond drill is expensive and its use is seldom justified except for structures of unusual size or where there are unusual foundation conditions.

The wash boring method is comparatively inexpensive and when used in connection with the earth auger it covers practically every condition. Where the earth auger will not penetrate deep enough, or where the borings must be made in the bed of the stream, the wash boring method is desirable. In the examination of bridge sites throughout North Carolina the Bridge Department has used with success a wash boring outfit described by Mr. Schuyler as follows:

"It consists of a 2 inch casing pipe which is driven into the ground by a 120-pound hammer pulled up by a hand in a set of 16 foot leads and allowed to drop. Inside of this casing pipe is a wash pipe ¾ of an inch in diameter through which water is forced under 30 pounds pressure by a 2 h. p. gasoline engine. The material is washed up between this pipe and the casing and is caught in a bucket or some vessel for examination. The outfit is transported from place to place in a G. M. C. light aviation truck rigged up especially for this purpose.

"Practically all of the material used in the construction of the outfit was obtained from surplus war material allotted to the state by the Federal Government, thus making the construction cost practically nothing. The truck in which it is transported was also allotted to the state from surplus war supplies. The total cost of operation, including all overhead expenses, runs about 75 cts per lineal foot of boring up to 50 feet, which is the greatest depth that the machine is capable of boring. The force required to run the outfit consists of an engineer in charge, truck driver who also operates the pumping engine, and two laborers who are obtained locally. One boring requires about one day, much of the time being consumed in unloading and making the set up.

"The saving to the state by the use of this outfit has been considerable, since the results obtained often bring about a change in the contemplated design and further enable the contractor bidding on the work to know what conditions he will encounter, thereby making it possible for him to submit a lower initial bid."



PILOT WITH FLANGES FOR DRIVING 3-INCH PIPE THROUGH EMBANKMENT.

Pipe Laying by Compressed Air

Use of an air drill to drive a pipe underground. Three-inch pipe driven through embankment.

The Commonwealth Edison Company has used a rotary air drill in a manner which suggests that the same device might be used for laying water and gas mains with equal success. In this instance the company desired to carry its wires under a railroad embankment 18 feet high and 75 feet wide, rather than use high poles for an overhead crossing. Instead of laying the conduits in open trench, it drove two 3-inch iron pipes through the embankment and carried the wires through them.

In driving the pipes through the earth, an air drill was used to rotate them and at the same time force them forward. The lengths of 3-inch wrought iron pipe were united with extra heavy couplings which had an outside diameter of 4.1 inches. A cone-shaped pilot was constructed, the cone being 3 feet long and 4.5 inches in diameter at the base, terminating in a cylinder 3 inches long. The cone was hollow and served partly as a reservoir for the lubricant, which was allowed to ooze out through six holes in the side of the shell, the escape of the lubricant being aided by a spring which forced a piston against the lubricant. On the outside of the cone were six flanges arranged in pairs and with a pitch such that, as the pilot was rotated from left to right, the flanges would draw it forward into the earth.

The flanges were effective for about 30 feet, but beyond this the friction was so great that positive feeding was necessary. A sleeve with a threaded interior was fastened to two anchors so that its axis coincided with the axis of the pipe. A hollow jack-screw 6.5 feet long was passed over the pipe and through this sleeve. In front of the jack-screw and fastened to it was a split pipe clamp. The jack-screw was then turned by the air drill, forcing the pipe forward. When it had progressed in this way 6 feet, the clamp was loosened, the air drill reversed and the clamp pulled back 6 feet, and again tightened on the pipe and forced forward. When the end of one length of pipe had been reached, a short piece was used as a spacer until the first pipe was far enough forward to permit inserting another standard length, when such length was substituted for the spacer. When the pilot had been

DRILL CONNECTED TO PIPE; WILMETTE PIPE FORCING JOB.
Driving gas service under boulevard pavement.

forced forward 45 feet it turned with great difficulty, which it was learned was caused by the fact that it had struck slag ballast that had been used under the track before it had been elevated. Through this ballast it required 8 hours to move forward 12 feet. From this on it rotated more easily and in another 6 hours the remaining 18 feet of pipe had been pushed forward and the pilot had reached the further side of the railroad right of way. An excavation was then made down to the pilot, which was found to be only 4 inches off the desired line. A second pipe was then installed in the same way, the pilot being 18 inches out of line when it reached the further end. The total time consumed in forcing the two lines of pipe was eight days. Probably by taking advantage of the experience gained the same work could be done again in half that time.

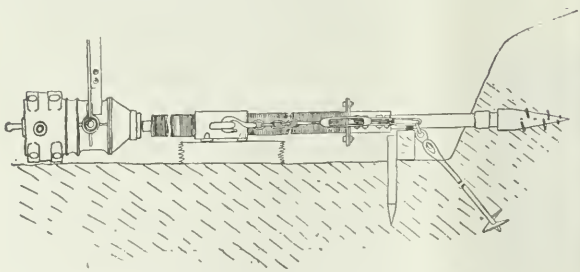
The total cost of the equipment and the wages of the crew for eight days was $335. This does not include the cost of pipe. What the cost would have been to have excavated through the embankment and laid the pipe it is difficult to estimate. The embankment contained a number of large rocks and, because of the continual passage of trains during the day time, it would have been necessary to work at night, with a railway force on hand to place any timbering under the tracks that might be required. It was believed that $500 would have been the minimum cost for this method.

The same pilot was used later for driving two 4-inch pipes and a 3-inch pipe under the street. The method is apparently practicable only for wrought pipes and not for cast iron pipes with their large bells. For a number of years it has been more or less common practice in several cities to drive 1-inch pipes for house connections by simply forcing them forward by means of jacks. The method described herein, however, has been used for 4-inch pipes and could, we presume, be used with even larger ones. It would appear to be too expensive for laying mains in general, but for avoiding tearing up streets which are to be crossed by pipe lines, for passing under embankments or any other locations where excavation would be unusually expensive, the use of this revolving device would seem to be worth consideration.

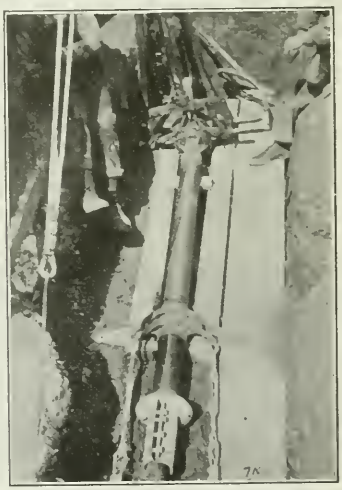
Cement Joints for Cast-Iron Pipes

The relative merits of lead substitutes such as leadite, hydrotite, etc., were discussed by the New England Water Works Association last fall and the discussion published in the "Journal" of that association this spring. After reading this discussion, B. D. Clarke, consulting water supply engineer, of Portland, Oregon, recently called attention to the fact that about six years ago, at his recommendation, the city of Portland began using cement for making joints in cast-iron water mains. This was undertaken because the author learned in 1913 of the experience of William Mulholland in using such joints in Los Angeles, and that of James D. Schuyler at an earlier date.

In 1915 or early in 1916, 1,000 feet of 8-inch pipe was laid with cement joints in Portland, "which proved to be so successful that other lines



FORCING 3-INCH PIPE THROUGH EMBANKMENT.
Sleeve anchored to the ground, hollow jack-screw, air drill and pilot.



VIEW OF SLEEVE, JACK-SCREW AND DRILL.

speedily followed until at the present time, as I am informed by Chief Engineer F. W. Randlett of the Water Bureau, practically no other calking material than cement is used, except in special cases where the main must be put in to use before the expiration of the 48-hour period necessary for the proper setting of the cement joint."

In making the joints, first quality, medium setting cement is used, mixed so dry that the impress of the hand will be left upon a small ball, which will crumble when let fall from the height of 12 inches. The spigot is supported at the proper position in the bell by placing a small bit of lead under it and just enough yarn is calked into the back of the annular space to keep the cement from entering the pipe. This annular space is then filled with cement which is thoroughly compacted with a yarning iron, and more cement added and compacted, until the face of the joint can be properly smoothed.

Up to the present time the city has laid approximately 7.8 miles of 4-inch to 16-inch pipe with cement joints, and about 4,000 feet of 24-inch to 30-inch pipe laid with lead joints has been taken up and relaid with cement joints in connection with grade crossing elimination. About 500 feet of 30-inch pipe was laid in tunnel, which afforded an opportunity to observe the leakage. It was found that there was considerable leakage at first but at the end of six months it had stopped entirely and all joints have since been tight. At another point 100 feet of 16-inch pipe that had been laid with cement joints was raised approximately 4 feet under the service pressure of about 70 lbs. without any leaks resulting.

Floating Islands in Storage Reservoir

The storage reservoir of Charleston, South Carolina, has a capacity of 2,781,660,000 gallons. The flooded area which now comprises the reservoir had formerly been the site of numerous rice fields which, after abandonment of the rice growing industry, had grown up with heavy marsh grass. This grass had sent its roots downward two or three feet and spread in all directions until they formed a closely interwoven mattress.

When it was decided to use this area for a reservoir it was thought unnecessary and prohibitively expensive to remove this vegetable growth and the marshy soil, it being believed that the flooding of the land would kill the vegetable matter and that it would be oxidized within a reasonably short time.

As a matter of fact, when the reservoir was flooded the mattress of roots and the marsh soil in which they were imbedded tore away from the soft underlying soil and floated to the surface. These masses of floating matter offered fertile soil for semi-aquatic and land plants, even small willow, cypress and pine trees growing on some of the larger islands. These islands have been drifting back and forth in the reservoir with the winds and currents for a number of years and the water company (which owned the plant until it was purchased about six years ago by the city) anchored a number of them in shallow places along the shore and removed others which had floated into and blocked the spillway entrance. In some cases willows had sent their roots into the bottom of the reservoir, anchoring the islands, and had grown into quite large trees.

It was feared that islands might float against the spillway, blocking it at a critical time. In fact, it was thought that this was one of the contributary causes of the overtopping and failure of the earth embankment of the reservoir in July, 1916. Another bad feature of these islands was that the rapid growth around them of the semi-aquatic plants threatened to cover the entire water surface and had begun to seriously interfere with the absorption of oxygen from the atmosphere.

The Water Department was authorized to undertake the removal of about 50 acres of these islands during the fall of 1921. No information seemed available as to the best equipment for doing this work, but a plant was constructed by the manager and engineer, J. E. Gibson, consisting essentially of a large rake operated as a drag line by which the material was drawn up onto the bank at the point nearest the island. Two 8-foot by 16-foot lighters were lashed together and on these were mounted a hoisting engine and a simple wooden tower for carrying one end of the drag line cable equipment, the other end of which was anchored on shore. The hoisting engine and cable equipment was hired for $400 and the rake was manufactured at a cost of about $245. The lighters cost $1,018; mounting the engine on them cost $56, and small boats and other apparatus cost about $81, or a total for the equipment of $1,800. The labor cost was $3,315, with $1,123 for superintendence and overhead and $50 for engineering; while fuel cost $208, supplies other than fuel, $206, and repairs, $63. This made the total cost $6,774. With this sum the department removed 125 acres of grass and marsh, or $54.20 per acre.

Since the removal of the islands not only is the reservoir more attractive in appearance but there has been a marked increase in the dissolved oxygen in the water and a corresponding decrease in its carbonic acid contents.

Mosquito Control by Use of Fishes

Investigation of the use of minnows and other small fishes for mosquito control have been undertaken by several investigators whose findings are being made public from time to time. Among the latest is a study by J. Percy Moore, professor of biology in the University of Pennsylvania, described in the report of the U. S. Commissioner of Fisheries for 1922.

Professor Moore carried on his investigations chiefly in the eastern parts of Pennsylvania and New York, although observations were made in other portions of those states and in New Jersey, Delaware and Maryland. (A previous investigation on the same subject made for the Government was confined largely to the southern waters. See PUBLIC WORKS for Oct. 8, 1921)

Professor Moore considered the value of the following fish in keeping down the growth of mosquito larvae: Roach or golden minnow, goldfish, mud minnow, common killifish, translucent killifish, common southern top minnow, blue-spotted sunfish, long-eared sunfish and the common sunfish. He concluded the roach and goldfish have little value as mosquito destroyers. The mud minnow has as its chief drawback the slowness of multiplication, which might be overcome by artificially propagating the fish. The common killifish has thoroughly established its value in limiting the number of salt marsh mosquitoes in New Jersey, New York and Connecticut. The author recommends the translucent killifish in preference to the common killifish for muddy ponds and sluggish streams. The top minnow is excellent for this purpose and increases with great rapidity, but does not occur naturally in the northern districts where these experiments were made and did not survive the winter in ponds in the vicinity of Philadelphia. However, a brood stock could be carried through the winter in a greenhouse or other suitable place for release the following Spring. Both the blue-spotted and the long-eared sunfish have considerable value, but Professor Moore found the common sunfish to be even more valuable, especially the young because they can reach the extreme margins of the ponds, being in fact nearly equal to the top minnow. So important does Professor Moore consider the work of fish in keeping down mosquito production that he says: "It may safely be said that were these fish suddenly wiped out, mosquitoes would immediately and generally become an intolerable nuisance."

River Intake Difficulties

Report on extension of the water supply of Memphis points out that cost of construction and operation of an intake in the Mississippi river, with other disadvantages, practically place river water out of the question for the present

A report on the development of the water supply of Memphis, Tennessee, has recently been submitted by Fuller and McClintock, consulting engineers, which, among other points, considers the obtaining of a supply from the Mississippi river. The quantity and quality of the Mississippi water present no unusual difficulties, but they report that "the construction of safe and reliable intake works and intake conduit would be more difficult and costly than any similar existing works on American rivers."

The river level at Memphis has a range of 46 feet between extreme low and extreme high water; firm foundation for an intake cannot be found at less than 100 feet below mean water level, and owing to the extreme height of floods, the intake would have to extend at least 50 feet above this level, giving a total height of the intake structure of at least 150 feet. It is believed that no reliable intake structure could be maintained except a substantial masonry pier founded on a caisson and carried to a depth of about 100 feet, where a stratum of hard clay is found, which is that upon which bridge piers at Memphis are founded. On top of the pier proper would be placed a superstructure containing living quarters for the intake keeper and devices for operating the intake, screens and gates.

Even with this substantial and expensive structure completed, there is no guarantee that it would continue serviceable for many years. The Mississippi river, which is notoriously unstable throughout its entire length below the mouth of the Missouri, has given examples of its freakish behavior at or just above Memphis. Opposite the northern part of the city is a bar where, prior to 1912, there was 60 to 80 feet of water at ordinary stages, the flood of 1913 having deposited about 80 feet of material over an area of many acres. At another point about two square miles of the old bed of the river, where there was formerly 5 to 50 feet of water, is now well above mean water level, while the river cut a new channel approximately 45 feet deep through the westerly end of an island, removing about half a square mile of land, parts of which were 25 feet above mean river level.

With these possibilities of channel changes, it is evident that there can be no guarantee that an intake structure located in the present channel will not, perhaps next year, perhaps 50 years hence, be buried by a sand bar and rendered absolutely useless. The engineers find no place within twenty miles north of the city where a pier could be located with assurance that it would not at some time be buried in a river deposit or perhaps abandoned by the river entirely. They find, however, that directly opposite the city, between the railroad bridges, there is a section relatively narrow and confined between the bluffs of Memphis on the one side and Hopefield Point with its protection works on the other, where the flood velocity is too high to permit of extensive bars forming and where the various commercial interests make it imperative to maintain this reach of the river in substantially its present position. This they believe is the only place practicable for an intake pier, since below this it would receive pollution from the city's sewers. Even here the intake conduit from the intake pier to the shore would have to be at least 100 feet below low water level, built in a tunnel driven by compressed air.

The idea was suggested of placing low-service pumping machinery upon a floating barge and delivering water through a flexible pipe line supported by floats to the end of a permanent pipe line on shore. The engineers, however, do not consider this either reliable or practicable, one objection being that readjustments of the positions of barge and floats would require shutting down for periods longer than could be tolerated.

They estimate that an intake pier at this point would cost about $1,000,000, while the tunnel would cost somewhat more than $1,000,000.

The intake might be constructed opposite the

southern part of the city, where the greatest security against channel changes would be found, but would here be subject to pollution by the city's sewers and the cost would be greater than for the location above described owing to the longer distribution mains needed as well as the cost of intercepting sewers to carry the sewage below the intake as far as possible.

In addition to the matter of cost, they anticipate that considerable trouble would inevitably be experienced at times due to clogging of the river intake and conduit by ice and sand. Also the river water would be appreciably harder than the present well supply unless softened at considerable expense, and in summer it would be warm and relatively unpalatable.

For this reason the engineers advise continuing the use of artesian wells rather than drawing upon the Mississippi river.

New Method of Purifying Water*

By H. W. Clark†

Lawrence Experiment Station loads a slow sand filter with aluminum hydroxide and secures good results at low cost for chemicals.

Probably the chief objection to slow sand filtration in the minds of many sanitary engineers and water works officials is that this method of water treatment seldom removes from the comparatively clear but often highly colored waters of the eastern states more than from 25 to 30 per cent of this color, and hence does not produce a filtrate as clear, sparkling, low colored and altogether attractive as the filtrate from coagulation and rapid filtration of such waters. On the other hand, perhaps the chief objections to the method of coagulation and rapid filtration when applied to these soft, highly colored waters, are the tendency of this method to increase the corrosive properties of the soft water treated; the difficulty with which as good bacterial results can be obtained by it, generally speaking, as by slow sand filtration—especially if these soft waters are badly polluted; and the fact now again being widely commented upon that occasionally aluminum sulphate does pass through such filters.

Owing to these objections or criticisms of the two methods, a process of water treatment that will produce a sparkling water of low color without materially increasing its corrosive properties, has been much desired and such a method I believe we have worked out at the Lawrence Experiment Station of the Massachusetts Department of Public Health. I am calling this a new method although we have been experimenting with it since the latter part of 1916 and have published in our reports short summaries of the results obtained.

Briefly, the process consists of loading the sand of a slow sand filter with the ordinary coagulants used in mechanical filtration and operating such a filter generally at slightly more than the usual sand filter rates, or about 5,000,000 or 6,000,000 gallons per acre daily. Filters loaded in this way remove a very large percentage of the organic matter, especially the coloring matter of the applied water and produce an effluent clear, sparkling and altogether attractive, containing no more carbonic acid than in the raw water applied to the filters and with the carbonate constituents of the water slightly increased.

This method of water treatment has many advantages over each of the other methods and but one drawback. The advantages are as follows: (1) The corrosive properties of the effluent are not increased or if so, not materially, and neither aluminum sulphate nor alumina is found in the filter effluent; (2) the aluminum hydroxide with which the filter is first loaded is regenerated whenever its color removal properties begin to fail and hence is used over and over again, that is, the primary cost of coagulants is practically the final cost; (3) when receiving comparatively highly colored water from storage reservoirs practically free from mineral matter in suspension, such as silt, etc., the method of filter regeneration or removal of stored color which we employ, removes practically all organic matter from the surface of the filter as well as from its deeper portions and hence the necessity for scraping the filter is largely obviated, that is, the expense of sand removal and sand washing is reduced to a minimum. Filters of this type now in operation at the Experiment Station have been scraped only once or twice during a period of five years' operation at rates of 5,000,000 gallons per acre daily; (4) there is, as I have already stated, practically no consumption of alum. Filters operated now for five years have theoretically used up-to-date, taking into consideration the amount of aluminum sulphate primarily placed in the filter and the volume of water filtered, about .2 of a grain of sulphate per gallon of water filtered or practically one-twelfth of the amount necessary per gallon in successful mechanical filtration of the Merrimack river water such as applied to these loaded filters. As the loaded filter increases in age and the volume of water filtered and decolorized increases, the theoretical or apparent use of alum grows less and less per gallon. Successful mechanical filtration of Merrimack river water costs in the neighborhood of $6 or $7 per million gallons for aluminum sulphate while with this new method the cost to date has been about 55 cents per million gallons for this sulphate, and this cost is constantly growing less: that is to say, if in the next five years we filter as large a volume of water as in the past five and without additional loading of the filter, the cost will be 28 cents per million gallons.

Up to date, we have operated eleven filters loaded with aluminum sulphate, but for purposes of this paper, the results of only five or six need be given. One filter, put into operation in January, 1917, and constructed of 4½ feet in depth of sand with an effective size of .25 millimeter, was loaded with 80 tons of aluminum sulphate per acre of filter surface. The aluminum hydroxide was precipitated in the sand by flooding the filter alternately with small

* Paper before the New England Water Works Association.
† Chief Chemist, Massachusetts Department of Public Health.

doses of solutions of soda ash and sulphate, although the filter can be loaded by mixing an alkali such as magnesium carbonate with the dry sand and then applying solutions of the sulphate.

During its five years of operation the average color of the effluent from this filter has been 14 and the color of the water applied to it, 41—a removal of 66 per cent. During long periods the color of the effluent has averaged 7, however, and during portions of these periods the applied water has had a color of 60, 70 and even 75; that is, the filter has given an average color removal during such periods of about 90 per cent. In other words, the color line of the effluent has always been nearly straight while the color of the applied water has had many high peaks and the higher the color of the applied water the greater the percentage of the coloring matter removed.

Some Results Obtained at the Lawrence Experiment Station During 1917-1922

Rate of each filter 5,000,000 gallons per acre daily.

	Filter Number					
	494	512	513	514	515	516
Tons of aluminum sulphate per acre precipitated in filter	80	75	75	150	150	225
Color removed (per cent)	66	73	73	73	78	76
Number of days between caustic treatments	65	67	67	89	89	90
Grains of caustic soda used per gallon of water filtered	.52	.21	.42	.16	.32	.16
Approximate percentage of wash water	2.5	3.7	3.7	2.8	2.8	5.5

Up to date, this filter has removed rather more than 50 per cent of the organic matter determined as albuminoid ammonia and 60 per cent of that determined as oxygen consumed. It has been treated with weak solutions of caustic soda twenty-four times in five years in order to remove the coloring matter held in the filter by the aluminum hydroxide. After this treatment with caustic such a filter is washed with a volume of water equal to about 2.5 to 3 per cent of that filtered between treaments and is then ready for service for a period of two or more months. It is not necessary to use filtered water for this washing out of caustic. The amount of caustic used up to date in the filter described has been .5 of a grain per gallon of water filtered, or, in other words, the expense for the caustic used has been about $2.50 per million gallons of filtrate. We believe, however, judging from later results, that we have used in this particular filter an excessive amount of caustic and that this figure may be much reduced.

A filter loaded with 150 tons of aluminum sulphate per acre has given an average color removal of 78 per cent during the past two years when operated at a 5,000,000-gallon rate and a filter constructed of sand as fine as .11 millimeter effective size and operated at a 2,500,000-gallon rate, has produced an absolutely colorless effluent since first put into operation. The cost of efficiently loading an acre filter is a small percentage of the cost of filter construction.

The bacterial results from this method are poor, as the caustic used removes from the sand grains much of the gelatinous organic matter so necessary for the retention of bacteria, but the effluent—clear, low in color and sparkling—is easily rendered practically sterile by the use of small amounts of chlorine, and chlorine is in almost universal use at filter plants at the present time in order that their effluents may be absolutely safe.

This method of treatment is particularly applicable to stored waters of a high color, the improvement of which physically is of more moment than the reduction of bacteria and it has seemed to us that there is no serious objection to it which would prevent its use upon a large scale. Recent experience has shown that perhaps the better way of loading the sand would be to carry this loading process on in comparatively small tanks or bins and then transport the sand to the filter. By this method more even distribution of the hydroxide would be obtained and stratification prevented.

In the discussion of the paper by the convention, Mr. Clark said that a more uniform distribution of the aluminum hydroxide might be obtained by dosing the sand in small tanks and then removing the coated sand grains to place in the filter; or the sand could be placed in the filter in successive layers, each layer being treated before the next is placed.

The PH (hydrogen ion) value of the filtered water is found to be increased. In reply to other questions, Mr. Clark said that the drawback to this process was the low percentage removal of bacteria —65. In preparing the solutions for treating the sand, he dissolved, for small filters, 6 pounds of aluminum sulphate in 50 gallons of water, and a little less than 3 pounds of soda in the same amount.

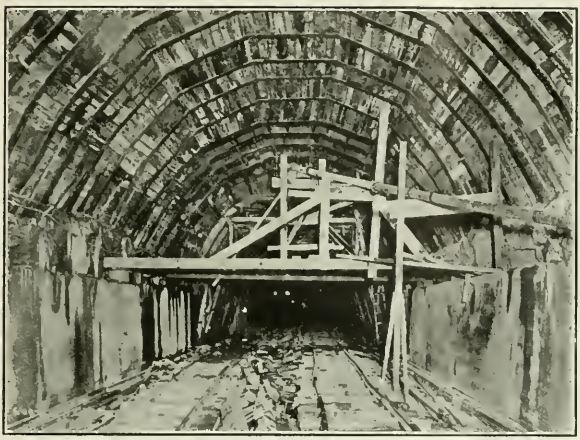
F. W. Green stated that he expected to try the process at the Little Falls filtration plant. Stephen De M. Gage stated that the process would apparently be of special value for Rhode Island cities, since physical improvement is more important than bacterial to the water supplies of that state with the exception of that of Providence.

Concreting Liberty Highway Tunnels

Placing about 9,000 yards of concrete in more than two miles of wide vehicular tunnels from four portals at average rate of 181 yards per day with dump cars, shoveling, and pneumatic process

The Liberty tunnels, Pittsburgh, which were described in Public Works, July 23, 1921, are parallel twin structures 59 feet apart on centers with horseshoe-shape cross-sections with an interior height of 27¼ inches and width of 26½ inches, length of 5,715 feet and a continuous grade of 0.4 per cent from end to end. The concrete lining, 24 inches thick, has a semicircular arch, slightly curved side walls and a thin concrete floor. Each tunnel contains an electric railway, a 13½-foot driveway and a 4-foot sidewalk, all for one-way traffic.

Alleghany County, Pennsylvania, awarded the contract to Booth & Flynn, who have nearly completed the work, at the price of $722 per linear foot. The work involved about 127,000 yards of excavation and 9,000 yards of concrete. The tunnel was driven through loose rock, soft shale and clay, some of which weathered badly and required immediate timbering. The tunnels were driven from



STEEL FORMS, DELIVERY PIPE AND WORKING PLATFORM IN PLACE FOR PLACING CONCRETE BY PNEUMATIC PROCESS.

all four portals, using the top heading and bench method, with practically continuous work in two shifts; first drilling from 7 to 11:30 p. m., blasting from 11:30 to 2 a. m., and mucking from 2 until 4:30 a. m. for the night shift, while the day shift set the timber wall plates in headings from 7 to 8:30 a. m., erected the heading timber from 8:30 a. m. to 1:30 p. m. and mucked from 1:30 p. m. to 4:30 p. m. Other shifts concreted from 7 p. m. to 6 a. m., and from 7 a. m. to 5:30 p. m. moved, set and fitted concrete forms.

The permanent timbering bents each consisted of seven segments made up of 32½-pound, 8-inch steel H-beams, 6 feet apart on centers, set on the timber plates and covered with 3-inch lagging. The steel bents were connected by tie rods and timber joggle blocks.

The headings were drilled with about 36 holes, 13 to 16 feet deep, and the bench with 16 to 20 holes in 12 lineal feet. They were blasted with about one pound of 40 per cent. dynamite per cubic yard, and the mucking was done with Marion No. 41 shovels having one and one-half yard dippers and operated by compressed air. The muck was loaded into 4-yard side-dump Western cars, hauled in six-car trains by an 8-ton 16-inch gauge electric mine locomotive, delivering them at the portal to 50-ton Climax steam locomotives, which hauled them to the dump.

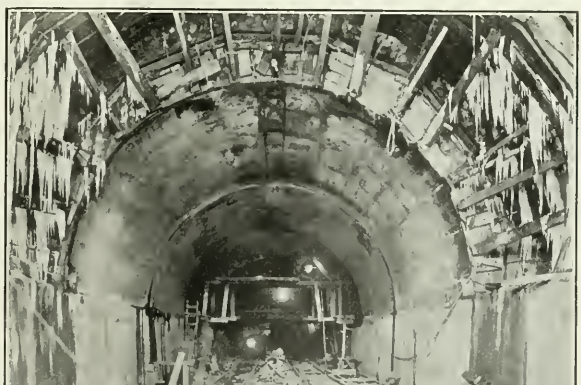
The construction, largely piece work, was well organized and progressed at an average rate of 12 linear feet per day.

The 1:2:4 concrete is made with Allegheny river sand and gravel and Portland cement. Every load of aggregate is tested for organic matter and for loam. At the south end of the tunnels the materials are delivered by railroad to a ¾-yard Ransome mixer and at the north end by truck to a one-yard Foote mixer, both mixers delivering to steel side-dump cars, which are hauled in five containers to the forms by electric locomotives.

The lining is poured in three successive operations. There is required for each linear foot of the tunnel 1.02 yards of concrete for the footings, 1.46 for the sidewalks and 5.08 for the arch. The daily progress is about 24 feet per section, amounting to 181 cubic yards at each point. That is a record of 325 linear feet of arch concreted, and placing 1,700 cubic yards of concrete in one week.

The steel sidewall form has a plank decking across the top just above the spring line, and is attached to a traveling steel inclined track 80 feet long. The concrete cars are pulled up this incline by a cable operated by one of the electric locomotives running on the invert tracks. The concrete is dumped onto the decking and shoveled behind the sidewall form. The footing sections are poured just ahead of the sidewall sections. At the same time that the sidewall concrete is being shoveled into place, the concrete from the front end of the decking is shoveled into wooden chutes leading down into the footing forms, so that these two sections are poured simultaneously. It usually requires about four hours to pour a 24-foot length of each of these two sections. The concrete is mixed as dry as workable and requires considerable spading for this reason. The spades are perforated with 10 or 12 holes ½-inch in diameter, in order to secure a good finish.

The arch concrete is blown into the form by a ½-yard Ransome pneumatic concrete blower which



SECTION OF FINISHED LINING, WITH BULKHEAD BRACED AGAINST ARCH BEAMS.

is installed under the side-wall form decking so that it moves along as the form is moved. The side-wall form decking is fitted with a small trap door so that if arch concrete is being placed, the cars are dumped onto the decking as in pouring side-walls and footings, while the concrete is shoveled into the blower through the trap door.

The concrete is blown about 100 feet with 80 to 100 pounds air pressure through a 6-inch conveying pipe, inclined up from the bottom of the blower to the crown of the arch. A special branch tee of manganese steel is used on the end of the discharge line, distributing the mix to each side of the arch simultaneously. The wooden joggle blocks between the steel segmental roof rings are removed before concreting while the steel tie-rods are left in place, and to these the steel arch reinforcement is securely wired.

The grout pipes through the steel lagging are extended through the form section to the skin of the form, while holes are cut in the lagging to insure the absolute filling of each ring section of arch by the pressure grouting performed later.

Tests for Granite Paving Blocks*

By Clarence D. Pollock†

The value of the present tests in determining the probable wear in pavements. French coefficient the only one giving reliable information.

In studying the present tests for granite in determining its suitability for paving blocks it may be well to study the history and development of these tests.

At first no tests were made, but the blocks were cut, paved and simply submitted to the service test. Architects had required the test for crushing strength of granite which was to be used in building construction. Some of the engineers thought that a test should be called for and knowing of the architects' test, they inserted this in the specifications. Various minimum requirements were used, varying from 15,000 pounds per square inch up to even 30,000 lbs. per square inch. When the minimum requirement was much over 15,000 lbs. it was found that many granites which had proved very satisfactory under the service test for long periods were barred out. A study showed that no very definite relation could be found between this test and the behavior of the granites under the actual traffic conditions. In 1915 this society adopted specifications with tests for impact or toughness and the abrasion test or French coefficient of wear including minimum requirements for moderately heavy traffic and heavy traffic.

At that time these tests seemed about as fair as any which had been tried, although they were not devised for this purpose. Since then, from observation of results obtained in laboratories and results in the pavements it has been difficult to find much relation between these tests and the actual service test in the streets.

These two tests were designed to measure the relative resistance to impact and wear of broken stone for use in macadam road pavements, and they do not to any great degree fit in with the conditions surrounding the use as paving blocks.

The object of this paper is not to advocate the abandoning of all tests, but to encourage experimental study for the developing of more practical tests by calling attention to the defects of those now used in the testing of granite for paving blocks.

In the toughness test the sample is very small, one inch diameter and one inch high, and great care is necessary in making the sample or there will be wide variation in results. A little carelessness in making the test specimens from the same sample may result in an error equivalent to 25% of the total range of all granites used in the Eastern portion of the United States. This chance for error detracts greatly from the value of the toughness test, aside from the fact that it is a test that does not approximate the wear conditions in the street.

FRENCH COEFFICIENT OF WEAR

In the test for French Coefficient of wear also the error may be as great as 25% of the total range of the granites, due to the method usually used in breaking the test pieces with a hammer which may start incipient fractures and also because of the irregularity of the shapes of the pieces for the test.

The Bureau of Public Roads has developed a machine for breaking out the test pieces by pressure which obviates the fault of incipient fractures and produces more regular shapes, but this cuts down the range of results on the various granites and makes it more difficult to differentiate the various granites.

This test does, however, show whether there is any real disintegration or not. The old idea that discoloration indicated disintegration has been thoroughly exploded. Discolored or "Sap" stone may in many cases show a greater strength than the clear stock from the same quarry. Real disintegration will show up in this test and herein lies its chief value in giving the relative strength of specimens from the same quarry, although it is not of much value beyond this in indicating how it will wear when paved in the street.

With the object of improving the present test for French Coefficient of Wear for granite block pavements, the laboratory of the Bureau of Public Roads has made modifications in the methods of preparing the test pieces for the Deval abrasion test as previously stated, the samples being broken into small cubical blocks by means of a machine instead of by hand. The machine consists of a 20-ton forcing press such as is used in automobile repair shops for forcing the gears

*Paper before American Society for Municipal Improvements.
† Consulting Engineer, New York City.

from shafts. This press is equipped with both stationary and movable knife edges and it has sufficient power to break a standard 5-inch granite block. This machine breaks the block into small cubes rapidly and much more accurately than can be done by hand and in addition avoids the danger of starting incipient cracks in the stone. In other words, the test pieces have good, clean, fairly regular faces and are approximate cubes.

Abrasion tests upon these fragments showed a greater coefficient of wear than the old method, but the results checked much better, although the range in values obtained with the different granites was much more limited than with the hand broken specimens. In order to increase this range, Mr. Jackson tried a modification of the abrasion test which was proposed by Messrs. Scofield, Mattimore and others, as follows: A number of longitudinal slots, each 1/16 of an inch in width, were milled in the abrasion cylinder, and the test was run on granite from 12 representative quarries making two or three tests on each kind of granite. Tests were also run on these same granites using the present method, and the results were compared. The elimination of the dust cushion gave lower coefficients of wear but the maximum variation of check tests was much less. In general, the coefficients of wear were somewhat over two points lower than with the present standard apparatus.

The total number of tests made was not sufficient to draw definite conclusions as to what minimum coefficient should be specified, but the maximum variation in check was sufficiently low to indicate that this was a step in the right direction. It is urged that more tests be made along this line and if they prove as consistent as those already made by the Bureau of Public Roads and several other laboratories, it may be possible to select definite minimum requirements to be used with these modifications in this test which will be an improvement on the present standard so that this test may be much more satisfactory than at present. This test is valuable as a means of proving whether a granite is disintegrated to any extent or not.

ACCELERATED TRAFFIC TEST

Several years ago the Bureau of Public Roads constructed 19 sample sections of granite block pavement from different quarries using different forms of filler and cushion and tested them by an accelerated traffic test which consisted of a machine having a frame carried upon rails which were parallel and on either side of the sample sections of pavement. These rails were supported firmly by concrete stringer or beams which also formed the sides of the pavement sections being tested. The subgrade was natural earth on a side hill having a gentle slope. Upon the subgrade 18 inches of rammed cinders were placed and then 8 inches of Portland cement concrete was deposited. On this foundation were constructed the various cushions and the test sections of granite pavement. In the frame of the testing machine were cast-iron discs having a diameter of 4 feet which ran freely in the frame. This frame was drawn back and forth over the test sections by means of a cable. This is the nearest approach to a service test which has yet been devised. However, it was not possible to draw definite conclusions from the results obtained as there was more or less settlement of the concrete foundation, probably due to the large amount of cinders underneath it, and the narrowness of the pavement between the concrete foundations of the rails. It would seem as though some such form of practical test could be devised which would not be so cumbersome or expensive but that the laboratories could afford to use it.

An important point to be borne in mind in devising a better test is not so much how individual blocks will act under the test as how they will act when combined as in a pavement with the usual joint spacing and the different fillers in the joints.

A simple form of accelerated traffic test would be the ideal one and approximations of this are what should be aimed at in securing a more practical test.

In summing up the value of the laboratory tests now used to determine the wear of granites in granite block pavements, the conclusion is reached that the test for French Coefficient of wear is the only one of value and the principal advantage of this is to determine if disintegration has progressed sufficiently to render the stone unsuitable for use in pavements, provided the coefficient of the normal clear stock of that quarry is known. The value of this test will probably be increased by using the modifications as were tried by the U. S. Bureau of Public Roads.

In the test for abrasion it would be advantageous to use the percentage of wear directly rather than the French Coefficient, as in the lower percentages of wear the equivalent French Coefficients change greatly for small percentage changes.

Garbage Reduction in Dayton

A brief summary of the operation of the Dayton, Ohio, garbage reduction plant given in the annual report of the City Commission for 1921, states that the cost of operating the plant in 1921 was $2.98 per ton of green garbage, as compared with $5.24 in 1920. This reduction was possible on account of reduced cost of labor and material.

However, the reduction in the prices obtained for grease and tankage was much greater. Garbage in 1920 sold at 10¼ cts. per pound, while in 1921 eight cars were sold at 1.95 cents and five cars at 3.26 cents. Tankage sold in 1920 for $10.43 per ton while in 1921 it was $7.08. Had the 1920 prices for grease and tankage prevailed during 1921, the total revenue from the sale of grease and tankage would have been approximately $85,000, whereas the total revenue actually received was about $21,500, a little more

than one-quarter as much. As the cost of operating the plant, including labor, supervision, hire of equipment, repairs, materials, etc., amounted to about $51,000, there was a loss in operation of about $29,500 in addition to the charges for interest and depreciation and other overhead expenses. Much better prices are being obtained this year and it is hoped that the amount received will be at least sufficient to pay the operating expenses. This experience at Dayton was that of all cities operating reduction plants, for which plants the year, 1921, was the most disastrous one that has ever been experienced in the history of garbage reduction.

State Indebtedness for Public Works

Figures for the bonded indebtedness of each of the states, two-thirds of which was incurred for highways, waterways and other public works.

The total bonded indebtedness of all the States aggregates a little over One Billion Dollars, and a little more than one-third of this was incurred for the construction of highways and bridges, while another third has been expended on other physical improvements such as waterways and harbors, park systems, etc.

This State expenditure for public improvements of course does not include all of the money spent in the State, by any means, but only that paid for by State funds. In most, if not all of the States, the additional amounts raised for this purpose by counties, cities and other political divisions, exceed that raised by the State. The relation between State-raised funds and other funds devoted to public works varies largely in the different States. In one extreme lie the States of Kansas, Kentucky and Nebraska with no bonded indebtedness whatever, Indiana with only $340,000 bonds raised for Purdue University, and Ohio with its only bonded indebtedness that devoted to "adjusted compensation" for World War Veterans; while at the other extreme lie Massachusetts with a total of $138,000,000, large items of which are sums devoted to abolition of grade crossings, metropolitan parks, sewers and water, and State highways; and New York with nearly $155,000,000 for canals, $100,000,000 for highways and about $13,000,000 for parks and miscellaneous purposes.

Considering the total indebtedness for all purposes, we find New York State leading with $267,784,000, or just about one-fourth of the entire total for the forty-eight States. Next comes Massachusetts with a little over $138,000,000, with California third with $73,683,000.

The total bonded indebtedness for highways is $367,687,000, which is distributed among twenty-three States, slightly more than half of the States having issued no bonds for this purpose. The highest bonded indebtedness for highways is that of New York, which is followed by California with $55,000,000, Pennsylvania with $50,000,000, Oregon with $31,700,000, Maryland with $19,877,000, and Massachusetts with $19,114,500.

It is somewhat surprising to note that the State indebtedness for water ways and harbors is far larger than for any other purpose except highways, totalling $213,891,400. This large State expenditure for this purpose, however, is accounted for largely by New York's indebtedness of $154,800,000 for canals, only five other States having incurred any indebtedness for this purpose; the next largest sum being that of Louisiana, $31,989,400.

These figures have been obtained and compiled by the Bank of America of New York City and were furnished, except in a few instances, by the State officials in direct charge of financial operations and are, therefore, believed to be reliable and complete. "The variety of record-keeping methods followed in the different States and the varying technical understanding of the term 'State debt' has made it somewhat difficult to lay down standard rules for compilation and to adhere to them strictly. As far as possible, the interpretation of the officials giving the information has been followed as to what constitutes indebtedness. But some modifications have been necessary to achieve a degree of uniformity to make the information at all comparable. The data include only 'bonded indebtedness,' items of current or floating indebtedness having been excluded."

The figures apply only to gross outstanding debt. "The absence of uniformity in the various State treasury offices in handling sinking fund or other arrangements for retiring the debt, as well as different interpretations of the records of such operations, has made it inadvisable to attempt to determine the net debt."

The figures given are, in the majority of cases, approximately correct for the end of 1921 or the Spring of 1922, some time, of course, having been required for obtaining the information and for compiling that obtained. In some cases, however, the

THE PURPOSES OF STATE INDEBTEDNESS

figures are not quite so recent, those for Louisiana being as of Jan. 1st, 1920, and derived from authentic sources, but not from the State auditor or treasurer, as is the case with most of the figures.

An examination of the date of issue of the bonds shows that almost one-half of the existing debt has been incurred since the United States entered the War and over one-third since the beginning of 1920, although only a small part of this has been directly caused by the war itself. For instance, $38,000,000 of California's indebtedness for highway construction has been issued since July 1st, 1917, all of Illinois' $11,000,000 road bonds have been issued within the past twelve months, as have $10,000,000 of Michigan's highway bonds and a considerable part of those of several of the other States. More than one-third of the total amount of bonded indebtedness has been incurred since June 1st, 1920.

In connection with the large sums raised for highways, it is to be remembered that a large proportion of these sums have been matched by nearly equal amounts contributed by the Federal Government under the Federal Aid Plan for highway building. Vast as seem these sums, the per capita debt of the States for highway development amounts to only about $3.50.

The largest individual item in any classification is the $154,800,000 with which New York State has been financing its canals. Only second in magnitude is the $83,775,162 spent by Massachusetts on the transit, water, sewer and park systems of the metropolitan district. Including the highways and bridges, waterways and harbors, park systems, etc., the actual physical improvements represent between 65% and 70% of the total State indebtedness.

"A close chronological study of the issues shows

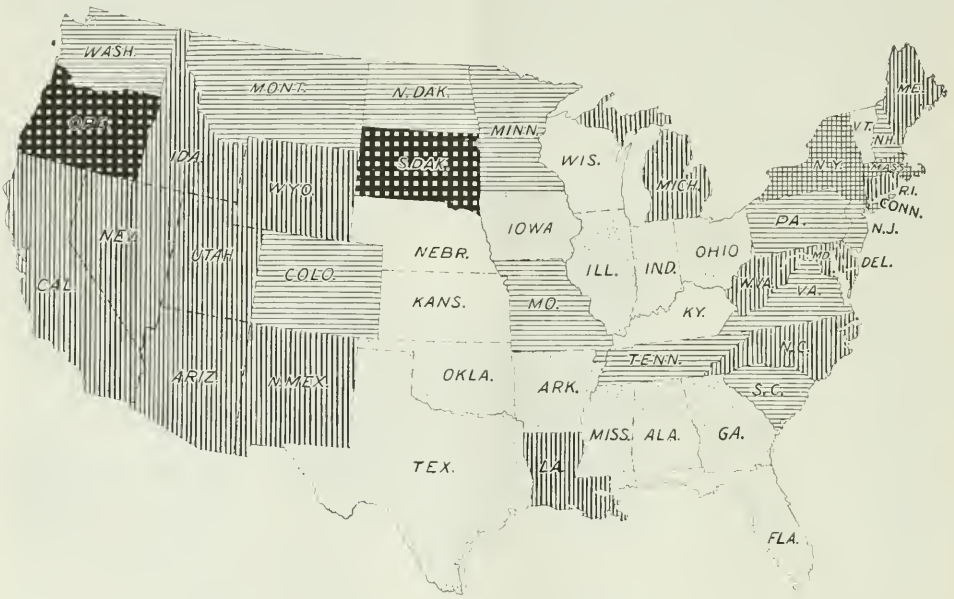
Bonded Indebtedness of States Devoted to Public Works.

	Total Debt	Public Buildings	Highways	Waterways and Harbors	Other Improvements
Alabama	$8,557,000.00	.....	.....	.....	.....
Arizona	3,913,275.29	$42,000.00	.....	.....	.....
Arkansas	2,538,166.67	.....	.....	.....	.....
California	73,683,000.00	5,600,000.00	$55,000,000.00	$13,083,000.00	.....
Colorado	6,554,500.00	.....	2,000,000.00	.....	.....
Connecticut	16,291,100.00	.....	.....	.....	.....
Delaware	4,880,785.00	.....	3,929,000.00	.....	.....
Florida	601,567.00	.....	.....	.....	.....
Georgia	5,530,000.00	.....	.....	.....	.....
Idaho	5,989,000.00	1,650,000.00	3,623,500.00	.....	$80,000.00
Illinois	11,017,500.00	.....	11,000,000.00	.....	.....
Indiana	340,000.00	.....	.....	.....	.....
Iowa	260,000.00	260,000.00	.....	.....	.....
Kansas	.....	.....	.....	.....	.....
Kentucky*	5,312,438.77	.....	.....	.....	.....
Louisiana	42,559,900.00	.....	657,000.00	31,989,400.00	.....
Maine	10,883,300.00	.....	6,264,500.00	650,000.00	.....
Maryland	30,475,880.55	.....	19,877,000.00	.....	1,000,000.00
Massachusetts	138,049,134.53	2,090,000.00	19,114,500.00	12,393,000.00	83,775,162.00
Michigan	45,550,000.00	.....	17,050,000.00	.....	.....
Minnesota	19,435,800.00	441,000.00	.....	.....	65,000.00
Mississippi	6,994,899.00	.....	.....	.....	1,948,899.00
Missouri	20,598,839.00	1,200,000.00	.....	.....	.....
Montana	4,103,000.00	724,000.00	.....	.....	.....
Nebraska	.....	.....	.....	.....	.....
Nevada	1,669,000.00	68,000.00	610,000.00	.....	.....
New Hampshire	2,490,500.00	.....	226,000.00	.....	.....
New Jersey	17,116,000.00	.....	5,000,000.00	.....	.....
New Mexico	3,853,500.00	185,000.00	940,000.00	.....	.....
New York	267,784,000.00	.....	100,000,000.00	154,800,000.000	12,929,000.00
North Carolina	27,732,600.00	3,622,000.00	8,052,600.00	.....	1,142,500.00
North Dakota	4,703,300.00	.....	.....	.....	.....
Ohio	20,000,000.00	.....	.....	.....	.....
Oklahoma	4,722,900.00	.....	.....	.....	.....
Oregon	42,695,125.00	.....	31,700,000.00	.....	.....
Pennsylvania	50,658,320.26	.....	50,000,000.00	.....	.....
Rhode Island	11,032,000.00	2,213,000.00	2,563,000.00	976,000.00	550,000.00
South Carolina	9,575,120.87	6,523.28	.....	.....	.....
South Dakota	47,700,000.00	.....	3,750,000.00	.....	.....
Tennessee	15,226,000.00	100,000.00	.....	.....	60,000.00
Texas	4,002,200.00	.....	.....	.....	.....
Utah	10,035,000.00	1,850,000.00	7,260,000.00	.....	.....
Vermont	1,675,500.00	140,000.00	.....	.....	.....
Virginia	19,380,337.57	.....	.....	.....	.....
Washington	12,500,000.00	.....	.....	.....	.....
West Virginia	26,427,500.00	.....	15,000,000.00	.....	.....
Wisconsin†	2,275,991.77	.....	.....	.....	.....
Wyoming	4,133,000.00	63,000.00	4,070,000.00	.....	.....
	$1,071,506,981.28	$20,254,523.28	$367,687,100.00	$213,891,400.00	$101,550,561.00

*Outstanding warrants (not bonded indebtedness).
†Certificates of indebtedness to School and Normal Funds of State (not bonded indebtedness).
"Highways" includes bridges and grade crossing elimination.
"Other Improvements" includes physical improvements other than highways, waterways or buildings.

that lump sum bond issues for a variety of purposes are decreasing in popularity, bond issues now more often being voted upon for specific purposes. The practice of funding into long-term obligations, floating debts incurred for minor purposes or even current expenses and annual operating deficits, appears to be almost extinct. This may certainly be considered an indication of the trend toward more scientific business control of State finances."

For the above figures and quoted comments and illustrations we are indebted to a pamphlet published by the Bank of America, entitled "A National Survey of State Debts and Securities." This pamphlet gives the itemized statement of each bond issue for



PER CAPITA GROSS STATE DEBTS

each of the States, its date of issue, amount, purpose, interest rate, date of maturity and the amount retired. It also gives and discusses the various classifications other than public works, such as welfare institutions, agricultural aid, soldiers' bonus, etc.; but we have touched upon only those purposes included in the general term of "public works," to which, as already stated, has been devoted about two-thirds of the total bonded indebtedness.

Lead in Cistern Water

The U. S. Public Health Service a few weeks ago was requested by the U. S. Employees Compensation Commission to investigate the cause of lead contamination of the cistern water at a fish hatchery on Ten Pound Island in Gloucester Bay. The suspected water was the drainage from the roof of the station building collected in a cistern of about 4,500 gallon capacity, made of brick and cemented on the inside.

The investigation indicated only three possible sources of contamination, a 6½-foot length of lead pipe which, however, had been removed in July, 1920; lead paint that may have gotten into the gutters or drains; and lead flashing at three places on the roof. As the cistern had been emptied and cleaned since the lead pipe was removed, this cause seemed to be out of the question, as did also lead in paint, since lead in paint is highly insoluble in water. It seemed to be demonstrated by elimination, therefore, that the lead in the cistern was derived from about 17 feet of strips of lead flashing on the roof. The possibility of lead reaching the cistern from this source is indicated by the regulations of U. S. Lighthouse Service for 1911, which contained the following: "To purify rain water contaminated with chloride of lead from salt spray resting in the leads of structures, put a small quantity of pulverized chalk or whiting into the cistern and stir well after each rain."

As a result of this investigation it is recommended that lead be not used in the construction of roofs, the drainage from which is to be used for drinking purposes.

Tabulated Sewerage Data

Supplementary data received since the publication, in the August issue, of figures received from several hundred city engineers in all parts of the country, giving the amounts and kinds of sewers laid during 1921 and 1922, jointing material used in pipe sewers, and other details.

Large Sewers Built in 1921 and 1922

	Brick Sewers Dimensions	Brick Sewers Length	Concrete Sewers Without Reinforcement Dimensions	Concrete Sewers Without Reinforcement Length	Concrete Sewers With Reinforcement Dimensions	Concrete Sewers With Reinforcement Length	Segment Block Sewers Dimensions	Segment Block Sewers Length
California								
Los Angeles	27″	1,611	....	....	....	....	....	....
Indiana								
Indianapolis	....	....	....	....	....	....	2′6″ to 6′0″	13,365
Kendallville	....	....	....	....	....	....	33″ & 30″	3,200
Massachusetts								
Amesbury	18″ & 24″	....	....	....	....	....	....	....
Michigan								
Battle Creek	22″x33″ to 39″x58″	30,613	....	4,180	....	1,404	....	6,821
New York								
Johnson City	....	....	....	....	27″—30″	9,466	....	....
Ohio								
Canton	96″ to 30″	18,244	....	....	....	500	....	....
Dayton	....	....	30″ to 108″	28,000	....	....	....	....
Middletown	....	....	....	....	6′3″x4′4″	4,932	....	....
Texas								
Wichita Falls	....	....	....	....	....	....	30″ to 80″	32,915
Washington								
Tacoma	....	....	....	13,527	....	13,830	....	....

Details of Sewers Laid in 1921 and 1922

City and State	Sanitary sewers, feet	Storm sewers, feet	Combined sewers, feet	Surface water inlets: With catch basins	Surface water inlets: Without catch basins
Alabama					
Talladega	....	....	....	40	....
Arkansas					
North Little Rock	2,435	11,290	....	....	63
California					
Los Angeles	422,546	....	....	....	....
Santa Ana	30,600	....	....	....	....
Connecticut					
Meriden	3,364	300	....	....	....
Indiana					
Indianapolis	110,545	20,230	75,000	180	96
Kendallville	70,000	17,000	58,000	....	....
Marion	2,500	1,500	....	12	....
Iowa					
Le Mars	7,061	....	....	....	....
Massachusetts					
Amesbury	1,500	....	....	....	....
Newton	18,523	....	....	5,000	....
Michigan					
Battle Creek	289,505	28,076	2,952	36	417
Nebraska					
North Platte	33,200	....	....	....	....
New Jersey					
Clifton	....	....	....	17	....
Millville	5,660	6,300	....	103	....
Rutherford	3,200	300	....	8	60
New York					
Gloversville	2,171	....	....	536	....
Johnson City	....	....	76,703	....	....
Ohio					
Canton	80,737.2	21,232.3	....	350	....
Dayton	53,000	23,000	....	....	....
Middletown	21,368	....	....	....	50
Oklahoma					
Ada	11,000	4,000	....	....	26
Oregon					
Eugene	....	.....	....	50	10
Pennsylvania					
Freeland Borough	....	....	....	20	12
Jersey Shore	22,090	....	....	....	....
Munhall	....	998	....	6	....
Texas					
Wichita Falls	155,362	18,227	....	1	70
Vermont					
Springfield	....	....	900	5	....
Washington					
Spokane	....	....	....	50	....
Tacoma	7,724	5,903	13,730	....	....
Wisconsin					
Green Bay	....	....	8,392	40	....
New London	3,300	....	3,300	27	....
Oshkosh	7	....	....	2,300	....

Pipe Sewers Laid in 1921 and 1922

City and State	Vitrified clay pipe—Length in feet: Less than 24"	Vitrified clay pipe—Length in feet: From 24" to 36"	Vitrified clay pipe—Length in feet: Larger than 36"	Cement concrete pipe—Length in feet: Less than 24"	Cement concrete pipe—Length in feet: From 24" to 36"	Cement concrete pipe—Length in feet: Larger than 36"	Other kinds of pipe sewers: Kind	Other kinds of pipe sewers: Size	Other kinds of pipe sewers: Length in feet	Jointing material other than cement mortar
Alabama										
Talladega	31,680	6,280	.....	.....	.....	.....	cast iron	....	....	.....
Arkansas										
North Little Rock	2,435	....	.....	10,612	680	.....	.....	....	....	.....
California										
Los Angeles	169,256	1,108	.....	249,171	1,400	.....	cast iron	8" & 20"	84	.....
							concrete and brick	27"	1,611	.....
San Bernardino	....	....	.....	.....	.....	.....	cast iron	4"	572	.....
Santa Ana	30,600	....	.....	.....	.....	.....	.....	....	....	.....
Santa Monica	13,260	....	.....	65,920	.....	.....	.....	....	....	.....
Connecticut										
Meriden	3,664	....	.....	.....	.....	.....	.....	....	....	.....
Indiana										
Elkhart	28,378	....	.....	.....	.....	.....	.....	....	....	.....
Indianapolis	86,950	2,070	.....	.....	3,060	.....	.....	....	....	.....
Kendallville	60,000	10,500	.....	.....	.....	.....	segment block	33" & 30"	3,200	.....
Marion	4,000	....	.....	.....	.....	.....	.....	....	....	.....
Iowa										
Le Mars	7,061	....	.....	.....	.....	.....	.....	....	....	.....
Massachusetts										
Amesbury	1,300	200	.....	.....	.....	.....	.....	....	....	.....
Newton	18,523	....	.....	.....	.....	.....	.....	....	....	sulphur and sand
Michigan										
Battle Creek	256,018	30,091	41,793	.....	1,325	4,259	.....	....	....	.....
Nebraska										
North Platte	33,200	....	.....	.....	.....	.....	.....	....	....	.....
New Jersey										
Clifton	1,200	115	.....	38	1,500	.....	.....	....	....	bituminous
Millville	8,670	....	.....	.....	970	2,336	.....	....	....	N. Carolina pine tar
Rutherford	3,200	300	.....	.....	.....	.....	vit. pipe encased in concr.	18"	3,300	.....
New York										
Gloversville	....	....	.....	4,100	....	.....	.....	....	....	bituminous joint material
Johnson City	69,747	3,381	.....	.....	9,467	.....	.....	....	....	bituminous
Ohio										
Canton	83,714	11,745	.....	.....	.....	.....	.....	....	....	G. K. compound or equal
Dayton	50,000	....	.....	1,000	.....	.....	.....	....	....	.....
Middletown	21,368	....	.....	.....	.....	.....	.....	....	....	.....
Oklahoma										
Ada	15,000	....	.....	.....	.....	.....	12" steel under tracks	....	....	.....
Oregon										
Eugene	....	....	.....	17,000	.....	.....	.....	....	....	.....
Pennsylvania										
Jersey Shore	22,090	....	.....	.....	.....	.....	.....	....	....	joint compound
Munhall	998	....	.....	.....	.....	.....	.....	....	....	.....
Texas										
Wichita Falls	126,824	7,832	.....	4,694	1,212	.....	cast iron	39" & 36"	80 & 132	.....
Vermont										
Springfield	900	....	.....	.....	.....	.....	.....	....	....	G. K. compound
Washington										
Spokane	48,600	2,700	.....	3,370	1,305	3,480	.....	....	....	.....
Tacoma	....	....	.....	15,879	5,096	6,382	.....	....	....	.....
Wisconsin										
Green Bay	8,392	....	.....	.....	.....	.....	.....	....	....	.....
New London	3,000	300	.....	.....	.....	.....	.....	....	....	.....
Oshkosh	1,600	....	.....	.....	.....	.....	.....	....	....	.....

Recent Legal Decisions

SEPARATE DEPARTMENTS OF MUNICIPAL PLANTS SHOULD CARRY OWN BURDENS

The Wisconsin Commission is of opinion that the electric consumers of a municipal plant should not be required to carry the burden of the water department. Each utility should stand upon its own feet. The larger portion of the operating expenses of the plants is chargeable directly to a particular utility and a particular class of service. The remaining expenses are common and must be apportioned between the utilities on a fair and reasonable basis.

RIGHT TO OPERATE MUNICIPAL ELECTRIC LIGHT PLANT

The Illinois Appellate Court holds, City of Sullivan v. Central Illinois Public Service Co., 221 Ill. App. 561, that a plaintiff who has never been given by ordinance the right to use a city's streets, and who purchased an electric light plant in the city while the city was operating and maintaining an electric light plant of its own, cannot claim that it is inequitable for the city to install and maintain such a plant of its own, but that it should grant the right to the plaintiff or purchase its plant.

DAMAGES TO CONTRACTOR'S EQUIPMENT BY CONSTRUCTION OF DAM

In an excavation contractor's action against a river drainage district for damages to machinery and equipment by the backing up of water through the erection of a dam in the channel of the river by the district, the latter claimed that an independent contractor alone was liable. The Illinois Appellate Court holds, Myers Construction Co. v. Wood River Drainage etc. District, 221 Ill. App. 473, that the district could not escape liability on evidence that the dam was constructed according to plans and specifications furnished by the district and under its engineer's direct supervision. The proper measure of damages was held to be the rental value of the contractor's machinery and equipment and the damages incident to the tying up of its men.

OPERATING EXPENSES AND TAXES OF MUNICIPAL PLANTS

In rate fixing cases involving municipal plants, the Wisconsin Commission says, in regard to taxes, interest and depreciation: "In estimating the costs for municipal as well as for privately owned plants, it would seem necessary to take into consideration the operating expenses, depreciation, taxes and interest on the investment. Operating expenses, including depreciation, are always present and must be actualy met, no matter by whom the plants are operated. Taxes and interest charges may, in a sense, be dispensed with for municipal plants. That is, neither taxes nor interest may be actually assessed against such plants. On the other hand, taxes and interest charge are present in some form in all industrial activities. Water works represent property that is of value and in which money has been invested. They constitute a part of the capital of the city. If such items as fixed charges are not considered by municipal plants in fixing rates for private consumers, it would seem that these consumers would be favored as against the taxpayers. There does not, on the whole, appear to be any equitable ground upon which such charges can be entirely eliminated in any industry or in connection with the service of any public utility." In re City of Kaukauna.

The laws of Wisconsin place a municipality, which owns and operates a public utility, under the same obligations as any other owner of a public utility. The Commission considers that the general functions of city government and the supplying of private needs should be kept separate and each be self-supporting.

QUESTION WHETHER CITY ENGINEER HAD ARBITRARILY REFUSED FINAL APPROVAL HELD FOR JURY

The general rule in regard to contracts for public works is that where the ultimate liability is made dependent upon the approval of the engineer in charge, or his certificate, or his final estimate, the contractor cannot recover in its absence, unless he shows a waiver of the requirements, or that he was entitled to this certificate, and that it was arbitrarily refused. But where, in an action by a contractor there was evidence that there was no reasonable cause for dissatisfaction with any of the contractor's work, and that the engineer's refusal to give final approval was due either to a mistaken belief that he could not do so unless the service director approved, or else to an effort to shift to the service director the responsibility for the decision which the engineer was required to make, though there was evidence to the contrary, it is held, O'Reilly v. City of Cambridge, 279 Fed. 961, that a verdict for the city could not be directed on the ground that the engineer's final approval had not been given, the decision being for the jury.

SCALE OF WAGES FOR CITY LABOR—DELEGATION OF COUNCIL'S POWERS

The Wisconsin Supreme Court, Wagner v. City of Milwaukee, 188 N. W. 487, holds that an ordinance which requires laborers employed on city work to be paid the prevailing wage of members of any labor organization, when approved by the members of the common council, and a resolution fixing a scale of wages accordingly, were void as being a surrender by the common council members of the exercise of their independent and individual judgments, and an agreement to be bound by the labor union scale if they acted at all on the subject. Any attempted vesting of the determination of such a legislative question in an outside body is an abdication, and not an exercise, of the legislative discretion that exclusively belongs to the common council itself. Three judges dissented, being of the opinion that the ordinance did not contain any delegation of legislative powers.

CITY'S RIGHT TO REQUIRE SPECIFIED PUBLIC UTILITY RATES AFTER EXPIRATION OF FRANCHISE

The Circuit Court of Appeals, Sixth Circuit, in City of Louisville v. Louisville Home Telephone Co., 279 Fed. 949, holds that where a rate fixing public service franchise has expired, and where there is no inconsistent statute, the city has an optional right to eject the corporation from the streets, but, so long as the city requires the corporation to continue to give public service, it must allow compensatory rates; citing the Denver Case, 246 U. S. 178, the Detroit Case, 248 U. S. 429, and the Toledo Case, 259 Fed. 4.0.

A city ordinance, which refers to further service and rates, may indicate an intention that the service must be given at the rates named, or an intention that the streets must be vacated and the service abandoned unless the company accepts the rates named. The city has the right to impose this choice upon the company, and if that intent is sufficiently apparent the company cannot continue both to use the streets and reject the rates.

SPECIFICATIONS FOR BIDS MUST FURNISH STANDARD FOR REAL COMPETITIVE BIDDING

The New York Supreme Court, Special Term, Monroe County, holds, Warnock v. Wray, 194 N. Y. Supp. 396, that, under the New York Education Law, §875, subd. 8, requiring contracts to be let to the lowest responsible bidder, the specifications are required to be in such form as to furnish a standard for real competitive bidding upon a uniform and intelligent basis. Under this section specifications for the construction of a substantial amount of work either of wrought iron or steel pipe in the alternative, prices being substantially different, do not furnish a basis for genuine competition.

New York General Municipal Law, §51, authorizes an action to prevent an illegal act or a waste of public funds and an injunction will be granted in an action by a taxpayer against a board of education to enjoin the letting of a contract under such a form of bidding. With respect to the letting of contracts for the construction of school buildings, involving the use of municipal funds affecting the city taxpayers, the board is subject to statutory municipal control, and to an action by the municipality, or by a taxpayer in its behalf.

RATES FOR PUBLIC FIRE PROTECTION SERVICE

The Pennsylvania Public Service Commission is of the opinion that the special nature of public fire protection service and the wide variation in estimates of its cost, depending upon the viewpoint taken and upon the characteristics of the particular property, make a determination of the proper charge for this service more largely a matter of judgment resting upon estimates of cost and a careful consideration of the extent, nature and value of the service and conditions existing in a particular case. It is furthermore a service, the cost of which is less influenced by variations in operating costs. Public fire protection rates established by a water company may be not unreasonable in form but in their application place an undue portion of the total burden upon the municipality. In the case of the Waynesburg Water Company, the Commission fixed as reasonable rates for this service $13 per hydrant per annum and $330 per mile of main 4 inches or greater in diameter.

AWARD OF CONTRACT TO LOWEST BIDDER

A mandamus will issue in the New York courts to compel a board of education to award a contract to the lowest bidder, the statute requiring contracts to be let to the lowest responsible bidder giving the security required, and there being no substantial reason for doing otherwise. Arenomeyer—Warnock—Zarndt v. Wray, 194 N. Y. Supp. 398. A reservation in a notice for bids in such a case of the right to reject all bids is not effective, where the contract is required by statute to be let to the lowest responsible bidder, and there is no statute giving such right in the discretion of the board, unless there is a substantial reason for rejecting all bids.

TAXES CANNOT BE LEVIED FOR LIGHT FURNISHED TO ONLY ONE SECTION OF A CITY

Considering an application for approval of a contract for the sale of electrical energy to the city of Gary, the Indiana Public Service Commission disapproved of a proposed clause in the contract under which the city would be required to levy taxes to pay for energy furnished to the city and resold to domestic consumers in a particular section of the city.

GRADING CONTRACTS—DUTY TO SUPPLY GRAVEL—WAIVER OF TIME LIMIT

In an action for balance due on a road grading contract the Arkansas Supreme Court holds, Brown & Froley v. Monroe County Road Improvement Dist., 241 S. W. 39, that where such a contract does not provide that the road improvement district shall furnish gravel to the contractor to keep his forces steadily employed, and that a failure to do so will render the district liable in damages, it must be presumed that the parties contracted with reference to all the conditions confronting them at the time, such as weather conditions and the difficulty of getting sufficient gravel, and failing such an express provision in the contract, liability for a breach thereof could not be maintained.

A provision in the contract for liquidated damages on failure to complete the contract by a certain date was held waived by the acquiescence of the district's engineer in suspension of the grading because of unfavorable weather conditions.

ADVANCES BY CONTRACTOR TO SUBCONTRACTOR UNDER AGREEMENT FOR REIMBURSEMENT FROM PERCENTAGE RETAINED

The Circuit Court of Appeals, Eighth Circuit, holds, Reeves v. McWilliams Co., 280 Fed. 100, that a drainage contractor, who advanced money to a subcontractor under the latter's agreement to reimburse him from the percentage of the contract price retained under the contract by the drainage district, had an equitable right and first claim on the percentage fund for reimbursement of the sum advanced.

NEWS OF THE SOCIETIES

CALENDAR

Oct. 1-8 — AMERICAN SOCIETY OF CIVIL ENGINEERS. Opening meeting of the season. Subject, "Structural Engineering." Secretary, Harold M. Lewis, 33 West 39th St., New York.

Oct. 16-19 — AMERICAN PUBLIC HEALTH ASSOCIATION. Annual meeting, Cleveland, Ohio. Secretary, A. W. Hedrick, 370 Seventh Ave., New York, N. Y.

Oct. 18 — BOSTON SOCIETY OF CIVIL ENGINEERS. Monthly meeting at Tremont Temple, Boston. Secretary, J. B. Babcock.

Oct. 27 — MINNESOTA SECTION, AMERICAN WATER WORKS ASSOCIATION. Fall meeting, Minneapolis.

Oct. 28 — ENGINEERS' CLUB OF NORTHERN MINNESOTA. Eveleth, Minn.

Nov. 1-3 — IOWA SECTION, AMERICAN WATER WORKS ASSOCIATION. Annual meeting, Iowa City and Cedar Rapids Secretary, Jack J. Hinman, Iowa City, Ia.

Nov. 2-3 — CENTRAL STATES SECTION, AMERICAN WATER WORKS ASSOCIATION. Annual convention, Pittsburgh, Pa. President, C. A. Finley.

Nov. 14 — NEW ENGLAND WATER WORKS ASSOCIATION. Luncheon meeting, Boston, Mass.

Nov. 14-16 — NORTH CAROLINA SECTION, AM. WATER WORKS ASS'N. Annual meeting, Gastonia, N. C. Secretary, Thorndike Saville, Chapel Hill, N. C.

Nov. 15-16 — NATIONAL INDUSTRIAL LEAGUE. Annual meeting. New York City. Secretary, J. H. Beck, Chicago.

Dec. 7-13 — NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING. New York City.

May 7-9 — AMERICAN ASSOCIATION OF ENGINEERS. Ninth annual convention, Norfolk, Va. Secretary, C. E. Drayer, Chicago.

AMERICAN SOCIETY OF CIVIL ENGINEERS

The opening meeting of the season of 1922-23 of the American Society of Civil Engineers will be held at the rooms of the society, 33 West 39th street, New York, at 8 p. m., Wednesday, October 18. As a preliminary to the regular meeting motion picture will be shown, 7:30 to 8:00 p. m., illustrating the Catskill Aqueduct.

M. Antoine, of Strasbourg, Engineer of the French Government, will give a short illustrated talk on the improvement of the Rhine and the Grand Canal d'Alsace, now contemplated to be executed by the French Government.

The widespread attention directed to the disastrous theater failures in Brooklyn and Washington makes this an opportune time to emphasize the importance of competent structural engineering in the construction of buildings. The structural engineer's duty in co-operation with others concerned in the making of a safe and suitable structure will be discussed by James B. French, Consulting Engineer of New York City; Rudolph P. Miller, Consulting Engineer of New York City (formerly Superintendent of Buildings, New York City); Hon. Lewis E. Pilcher, Architect, State of New York; Daniel T. Webster, Manager, Marc Eidlitz Sons, Contractors, New York City, and Lewis D. Rights, Contracting Engineer, Shoemaker-Satterthwait Bridge Co., New York City; followed by open meeting talk by others interested. A short business meeting will be held during the evening.

At the meeting of the society on October 4th two papers were read and discussed, one on "Experiments with Models of the Gilboa Dam and Spillway," by R. W. Gaussmann and C. M. Madden, and the other on "Engineering Geology of the Catskill Water Supply," by Charles P. Berkey and James F. Sanborn.

The Board of Directors met in San Francisco on October 2 and 3. The board decided to hold the spring meeting in New Orleans at a date to be decided later, the topic for the meeting to be: Ports, Harbors and River Control. The following resolution was passed: "That this board is in sympathy with a movement to join the Federated American Engineering Societies when financial and other conditions permit," the matter to be discussed at the January meeting.

ILLINOIS SECTION, AMERICAN SOCIETY OF CIVIL ENGINEERS

A dinner meeting of this section was held on Wednesday evening, September 20, in honor of the secretary of the society, John H. Dunlap. It was attended by over fifty local members. Mr. Dunlap, in his address, acquainted the local members with the plans and possibilities of the national society. The treasurer of the national society, O. E. Hovey, was present, and stated that the finances of the society are in excellent condition.

CHICAGO ENGINEERS' CLUB

This club has recently elected the following officers: President, Homer E. Niesz; Vice-President, C. C. Brooks; Secretary, George H. Clucas; Treasurer, Vernon C. Ward; Trustees, George E. Waldo and Frank D. Chase.

LEAGUE OF CALIFORNIA MUNICIPALITIES

The twenty-fourth annual convention of the League of California Municipalities was held at Stanford University and Palo Alto on September 19 to 22. Among the papers on the program were: "Budget Experience of California Cities," "Problems of a City Manager," "Garbage Collection and Disposal," "Getting Results in City Planning," "Palo Alto's Street Work Procedure," "The Boulder Canyon Project," "California's Water and Power Act," "Water Development in Sacramento, San Jose, Los Angeles and Santa Rosa."

AMERICAN ASSOCIATION OF ENGINEERS

The quarterly meeting of the Board of Directors of the American Association of Engineers, held September 29 and 30, "demonstrated the practical results that are to be had from the present form of organization whereby a director represents a defined district," in the opinion of A. N. Johnson, president of the association. At the board meeting sixty per cent. of the annual dues was assigned to the Michigan Division and Southwestern Division and to fifteen chapters rated as "Class A"; affiliations of the Detroit and Boston chapters with local technical societies were approved; charters were granted to the societies in Grand Rapids, Michigan, and Orlando and Palm Beach, Florida; provision was made for extension of membership among engineering students in colleges, and the National Legislative Committee was instructed to review the Model License Law of the association and make recommendations for modification by December 1 for the information of states planning to introduce bills in the 1923 Legislature.

AFFILIATED TECHNICAL SOCIETIES OF BOSTON

The Bulletin of the Affiliated Societies for October announces meetings of the Boston Society of Engineers on the evening of October 18, where papers on bridges will be presented, illustrated by lantern slides. "The Construction of the Pre-cast Concrete Slab Bridge at Central Street, Lowell," will be described by S. Stanley Kent; "A Survey of Massachusetts Bridges" will be given by William F. Williams; "Strengthening Old Bridges" will be discussed by Lewis E. Moore, and "A Long-Span, Reinforced Concrete Girder Bridge at Cohasset Narrows" will be described by B. A. Rich.

On November 8 the Designers' Section of the Boston Society of Civil Engineers will hold a meeting, where "Handling Materials by Conveying Machinery" will be discussed by Nixon W. Elmer.

On November 10 will be held the regular monthly meeting of the Boston Chapter of the American Association of Engineers.

On November 14 the New England Water Works Association will hold a luncheon meeting at the Boston City Club, where Dr. Richard Moldenke will present a paper on "Iron Castings"; the U. S. Cast Iron Pipe and Foundry Company will show motion pictures of the centrifugal process of casting pipe, and S. R. Church, of the Barrett Company, will speak on "Tars."

On November 18 the Northeastern Section of the American Society of Civil Engineers will hold a luncheon meeting at the Boston City Club. This section held a luncheon meeting on September 9, which was attended by forty members and guests, the guests including members of the Executive Board of the American Engineering Council, who were meeting in Boston on September 8 and 9.

Preliminary plans have been made for the first affiliation meeting, to be held

on Thursday, November 23. The subject will be "Commercial Aviation, the Present State of the Art," with special reference to the development of Boston as an air port. The program will include papers on "Commercial Aviation in Europe," "The Development of Heavier-Than-Air Machines" and "The Development of Lighter-Than-Air Machines."

PERSONALS

Wolman, Abel, has been elected chief engineer of the Maryland State Department of Health to succeed Robert B. Morse, resigned. He will continue as lecturer in sanitary engineering in the Johns Hopkins University School of Hygiene and Public Health, and as editor of the journal of the American Water Works Association.

Duff, Edward E., Jr., has been elected secretary of the National Paving Brick Manufacturers' Association to succeed M. B. Greenough. He is at present District Engineer of the Eastern Paving Brick Manufacturers' Association.

Fuller, Weston E., has withdrawn from the firm of Hazen, Whipple & Fuller, of which he has been a member since 1908, to become Professor of Civil Engineering at Swarthmore College. He will continue practice in civil engineering.

Kinnally, R. W., formerly resident engineer of the South Dakota Highway Commission, has resigned and joined the contracting firm of W. J. Cole at Huron, South Dakota.

Warner, B. L., formerly resident engineer for the South Dakota Highway Commission, has resigned and now occupies a similar position with the Illinois Highway Commission.

Gatchell, O. W., formerly assistant engineer with the Ohio State Highway Department, is now with Frank T. Miller, consulting engineer, of Greensboro, North Carolina.

Myers, Ray Z., formerly assistant engineer of Licking County, Ohio, has been appointed assistant division engineer of the Ohio Highway Department.

Russell, H. W., formerly senior civil engineer with the Interstate Commerce Commission, is now with the Department of Tests of the Illinois Division of Highways.

Buhrmeister, F. W,. formerly junior highway engineer with the Illinois Division of Highways, is now with the American Bridge Company as detailer.

Bennett, J. G., until recently city manager of Ft. Myers, Fla. ,is now with the Wisconsin Highway Commission in the Bridge Designing Department.

Schrader, F. H., formerly resident engineer of the South Dakota Highway Commission, has been promoted to the position of district engineer, located at Brookings.

Pimm, A. B., county engineer of Hillsboro County, Florida, has been appointed by the county commissioners as engineer in charge of the construction work under the three million dollar bond issue.

Camp, Thos. R., recently city engineer of Breckenridge, Texas, has joined the firm of Hawley & Sands, consulting engineers located at Ft. Worth and Houston.

Allee, C. R., has recently been employed by the Port Jervis (N. J.) Waterworks.

Bryson, T. B., construction engineer associated with Holbrook, Cabot & Rollins, contractors of New York, died suddenly at his home September 5.

Costello, D. L., has been appointed resident engineer with the Massachusetts Bureau of Highways, stationed at South Egremont.

Bowlus, George F., formerly assistant engineer on dock construction at Superior, Wis., for the Great Northern, has recently joined the ranks of the Minnesota State Highway Commission, and will be located on construction work at Elgin, Minn.

Morgan, R. D., formerly city engineer of Temple, Tex., has recently resigned and been appointed superintendent of water and sewers at Mexia, Texas.

Webb, T. H., has been appointed assistant state highway engineer of Texas.

Bennett, Boyd A., recently director of public works of Lynchburg, Va., on September 1, became city manager of Charlottesville, N. C.

Cottrell, E. H., has been appointed city engineer of McKinney, Tex.

Schultz, Chas., recently city engineer of McKinney, Tex., has been appointed city engineer of Tulsa, Okla.

PAMPHLET NOTES

"Recommendations on Future Policy in Stream Pollution Investigation Work." Article in Public Health Reports for August 25, giving recommendations of Messrs. Forbes, Jordan & Pearse as to the work which can be performed most profitably by the U. S. Public Health Service in carrying out its stream pollution investigation work.

"Use of Semi-Log Paper in Plotting Death Rates." Article in Public Health Reports for August 18 by Professor George C. Whipple in which he sets forth and illustrates by a number of examples the advantages of using semilogarithmic paper for plotting death rates and studying changes in their general tendencies.

Reports on water works of Council Bluffs, Ia., and Omaha, Neb., together with fire departments, Structural conditions and hazards, as prepared by National Board of Fire Underwriters.

"Composition and Characteristics of the Population by States." Vol. III of the Fourteenth Census, giving the figures taken in 1920. This classifies the population of each state according to color or race, nativity, parentage, sex, age, illiteracy; also gives school attendance, and combinations and group classifications of these figures. Most of these are given for 1910 as well as 1920, and classified as urban and rural.

"Annual Report of the Dept. of Public Utilities of Massachusetts." This report for the year ended Nov. 30, 1921, is published in two parts: Part I, of 272 pages, giving the report text, and Part II, of 506 pages, giving the returns, mostly in tabulated form, of the several gas, electric and water companies and municipal plants. These annual reports are of great value to all students of these classes of public utilities.

"State Investigation of Public Water Supply of Delaware, Ohio." This report is published as part of the August 11 issue of Public Health Reports by the U. S. Public Health Service. It gives, in fifteen pages, the report of F. H. Waring, principal assistant engineer of the Ohio State Department of Health.

"Ohio Law for Enforcing Correction of Stream Pollution and Improvement of Public Water Supplies." This law, with the latest amendments thereto, is published in full by the U. S. Public Health Service in Public Health Reports for August 11.

"Proceedings of the American Society for Municipal Improvements." Papers and discussions, and business transactions of the society at the convention of October, 1921. Includes four papers on street lighting, three on water works, seven on sewerage, fifteen on paving and paving materials and three reports on paving specifications, and eighteen others on conduits, markets, public comfort stations, city planning, snow removal and other topics.

"Special Assessments." A report of the Committee on Sources of Revenue of the National Municipal League, discussing and citing instances of the principles and practices as to special assessment administration. Special number of "National Municipal Review," a publication of the National Municipal League.

"Source of Lead Contamination of Cistern Water" a paper in Public Health Reports by Leonard Greenburg, assistant sanitary engineer. This article, published in the July 28 issue, is the report of an examination of the drinking water supply system at the U. S. Fish Hatchery station, Ten Pound Island, Gloucester, Mass., for possible sources of lead contamination. These reports, issued weekly, contain data concerning the prevalence of disease in the United States and foreign countries, the deaths during the third week before issuance, and articles on health matters. About 40 pages. Can be obtained from "Surgeon General," U. S. Public Health Service, Washington, D. C.

PUBLIC WORKS.

CITY COUNTY STATE

A Combination of "MUNICIPAL JOURNAL" and "CONTRACTING"

Vol. 53 November, 1922 No. 9

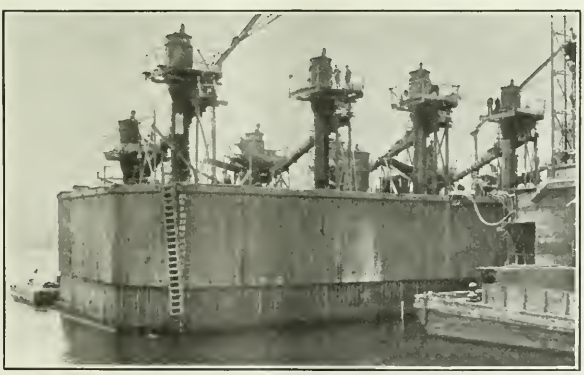
Delaware River Bridge Piers

Design of the river piers and their pneumatic caissons for the bridge between Philadelphia and Camden now under construction—the longest suspended span yet constructed.

The municipal bridge across the Delaware River at the foot of Race Street, Philadelphia, will extend from the foot of Race Street, Philadelphia, to Pearl Street, Camden, and will be built under the direction of the Joint Commission from the States of Pennsylvania and New Jersey and the supervision of a board of bridge engineers, of which Ralph Modjeski is chief engineer and George S. Webster and Lawrence A. Ball are consulting engineers.

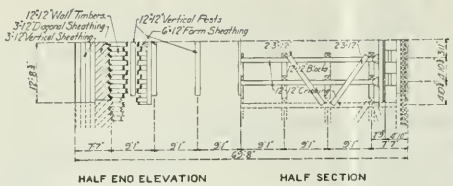
The bridge will include a suspended channel span of 1,750 feet, center to center of piers, and suspended side spans. It will have two decks and carry electric car tracks, two roadways and two sidewalks. The river span will be the longest of its kind yet built, exceeding by 150 feet that of the Williamsburg span, the longest yet completed.

The river piers, 1,750 feet apart on centers, have their foundations carried through mud, sand and gravel, to bearing on bed rock at a maximum depth of about 86 feet below datum, which is about 2.43 feet below mean high water. The top of the pier is I-shape in plan with a maximum width of 40 feet, minimum width of 14 feet and length of 105 feet, having at each end large bearings for the bases of the steel towers, which are 27.75 feet above datum. The sides and rounded ends of the piers are battered 1:24 and are faced with cut granite to an elevation below water level. The foundations of the piers were built in pneumatic caissons, 69 feet, 8 inches wide and 143 feet long over all, which, with their fixed and movable cofferdams, had a total maximum height of about 74 feet. The piers and their foundations are constructed of 1:2:4 concrete, having a required strength of at least 2,000 pounds per square inch, and 1:2½:5 concrete, having a specified strength of 1,600 pounds when 28 days old.



PIER A CAISSON AND EQUIPMENT.

The caissons, 69 feet, 8 inches wide and 143 feet long over all, and 43 feet high from the cutting edge to the tops of the permanent cofferdams, were built with a steel working chamber 8 feet, 2 inches in height, having vertical walls continuous with the solid walls of the permanent cofferdams, made with 12x12-inch timbers with vertical and diagonal outside 3x12-



DETACHABLE COFFERDAM FOR PNEUMATIC CAISSONS.

inch sheeting and with connections at the top for securing the detachable cofferdams of similar construction, which reach above water level.

The roof of each cassion was supported by four transverse solid timber bulkheads 36 inches thick, made up of 12x12-inch yellow pine timbers that were intended to serve only as intermediate supports for the steel roof and the pier above it. The bulkheads are each made with two 3x4-foot openings to provide communication between the adjacent compartments of the working chamber. The steel cutting edge is heavily reinforced.

There are seven longitudinal riveted steel trusses with their lower flanges riveted to the steel plate roof of the working chamber and their ends riveted to pairs of vertical 12-inch channels secured by flange bolts 24 inches apart to the timber walls of the caisson and cofferdam. Above the trusses ,the caisson was braced with horizontal 12x12-foot transverse and longitudinal timbers in the plane of the trusses, which, like the latter, divided the interior of the caisson into panels 9 feet 1 inch by 9 feet 10 inches on centers. The timbers are supported by vertical posts at the panel points of the steel trusses and are made in lengths of about 30 feet joined with steel fish plates.

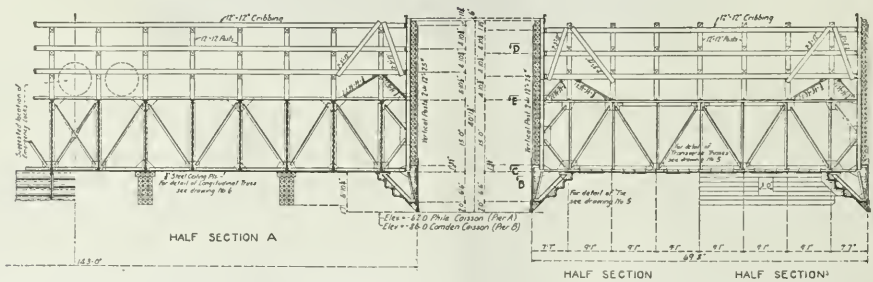
Similar bracing is provided for the removable cofferdam on top of the caisson, which is detachably connected with the latter with hooks and wedges. The detachable cofferdam for the Philadelphia pier was 12 feet high and the ends of its two piers of horizontal bracings took bearing through large steel U plates bolted to the vertical members of the cofferdam. Each side of the cofferdam consisted of three detachable panels connected at the corners to the adjacent panel with bolts. As the pier shaft is narrower than the foundation, the cofferdam was offset about 3 feet on each of the long sides from the faces of the caisson wall, the spans being covered by a solid timber deck, 12 inches thick.

Great pains were taken by the engineers and contractors to make every possible provision for the safety of the workmen, to insure the rapid and economic placing of the concrete, and that it should form a solid mass completely filling the caisson and leaving no holes or air spaces in it or in the cofferdam itself.

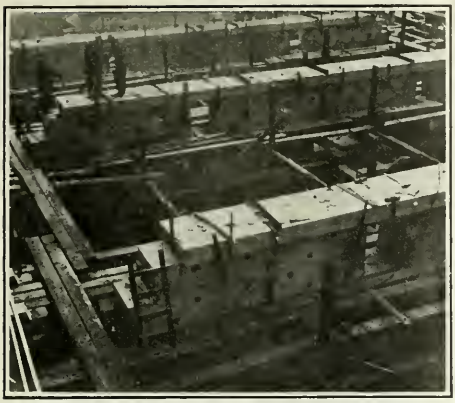
All of the muck is removed through 10 vertical shafts, 3 feet in diameter, surmounted by Mattson air locks, which were equipped with cylindrical buckets hoisted by wire cables, passing through stuffing boxes in the tops of the locks and then over guide sheaves to two-drum Lidgerwood engines. The locks were provided with side doors, through which the buckets were tilted to empty into wooden chutes with their lower ends projecting beyond the outside of the cofferdam so as to discharge into scows alongside, which were towed away and dumped. The same vertical shafts were used for filling the working chamber with concrete.

A 4-foot vertical shaft, provided with an elevator hoist and an air lock, was installed for the use of the workmen and there was also built, not much above the roof of the working chamber, a long refuge chamber 7 feet high in the solid concrete filling of the caisson and communicating through open hatches with vertical ladders to each of the five main compartments of the working chamber. This refuge chamber or "tunnel," as it was called on the work, was intended to safeguard the men in case of emergency, when it would serve as a trap to retain a large quantity of air, no matter what conditions might exist in the working chamber or what water might penetrate to it. This tunnel communicated with two horizontol cylindrical air locks, 7 feet in diameter and 15 feet long with a capacity for about 40 men, which were installed at the same level at the foot of an open well having walls of reinforced concrete 5 feet thick and containing stairs providing ample exits for the workmen. All of the vertical steel shafts were provided with horizontal hinged doors, kept closed when not in service. The tops of the shafts are always maintained above water level.

Each manlock was provided with a special re-



LONGITUDINAL AND TRANSVERSE SECTIONS OF PNEUMATIC CAISSON FOR RIVER PIERS. DETACHABLE COFFERDAM NOT SHOWN.



TRANSVERSE BULKHEADS FOR WORKING CHAMBER OF CAISSON.

cording air guage, showing the amount and change of air pressure in the air lock within any five minutes. The guages were kept in locked, waterproof boxes and were frequently tested and maintained in accurate working order. Compressed air was supplied to each of the five main compartments of the working chamber through two 6-inch and two 4-inch pipes. The air supply pipes were fitted with a lock valve besides having an automatic enclosed check valve. When the men were in the working chamber, air was supplied to it through the two separate lines of piping, which were also connected to the refuge chamber. A pulsometer was also installed in each corner of the caisson to remove all leakage, but the caisson has proved to be so tight that little service has been required of them.

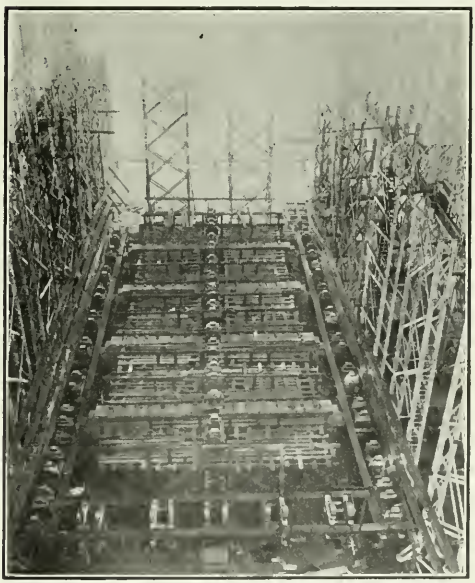
M. E. Case is resident engineer for the Delaware River Bridge Joint Commission, D. A. Hughes is superintendent of construction, S. M. Swaab is chief engineer of the Keystone State Construction Company, and Carleton Greene is engineer for Holcombe, Cabot & Rollins.

BUILDING AND LAUNCHING CAISSONS

The two 143x70x43-foot steel and wood pneumatic caissons for the river piers of the bridge were built on covered ways of the New York Shipbuilding Company at Camden, New Jersey, by the shipbuilding company as subcontractor. Each caisson has a working chamber 8 feet 6 inches high with steel plate walls and roof surmounted by solid timber walls 12 inches thick, braced by 21 longitudinal and transverse riveted steel trusses 15 feet deep and by three tiers of 12x12-inch horizontal transverse and longitudinal struts above the trusses. The roof of the working chamber is supported by the steel wall and cutting edge and intermediately by four solid longitudinal bulkheads three feet thick.

The caissons were built with their longitudinal axes perpendicular to the shore line and with the cutting edge and transverse bulkheads supported on two regular ship ways inclined 7/8 inch in 12 inches. These ways were installed in covered slips equipped with plate girder electric traveling cranes of 50 and 100 tons capacity that run from end to end of the ways on tracks at two different levels enabling the cranes to pass under and over each other. These cranes handled all of the material required in the caisson construction and were supplemented by a complete line of pneumatic tools for boring, drilling, riveting, and caulking, which eliminated a large amount of hand work and expedited the construction of the caisson.

The transverse bulkheads, 7 feet high, 10 feet thick and about 55 feet long, weighing 84 tons each, were assembled and bolted together complete in the shipyards and then, as units, were set in place on the ways by the 100-ton crane. Falsework was built parallel to them to support the steel plate roof of the working chamber, which was assembled on blocking about four feet above the top of the bulkheads so as to give clearance for convenience in riveting. The steel cutting edge, roof and sidewalls were assembled in position and riveted complete, while the transverse trusses were assembled and riveted up and set in position on the steel roof by the traveling crane. The longitudinal trusses were delivered in separate pieces and short sections were assembled to the transverse trusses after the latter were in position. After the completion of the stiffening trusses, solid courses of 12x12-inch wall timbers and the two courses of vertical and diagonal sheathing planks were bolted on, all of the timbers being dressed accurately to dimensions one-quarter inch less than nominal. All boring was done with pneumatic tools and rivets were driven by pneumatic riveting guns. Seven gangs of riveters were employed on the trusses and steel roof. The outside



BULKHEADS ON WAYS, BLOCKING READY TO SUPPORT STEEL ROOF.

course of sheeting was caulked with oakum.

All of the horizontal timber braces for the second caisson were cut, assembled in the yard, match-marked, holes drilled, taken apart and reassembled in the caisson.

After the rivets in the steel walls and roof were driven they were tested in the usual manner by tapping with hammers to detect any loose rivets. The workmanship was of high class, and the riveting and caulking were so good that very few leaks developed when the caissons were launched.

After the completion of the steel work, the four 84-ton timber bulkheads were hoisted 4 feet and pulled up against the underside of the roof by tackles suspended from the overhead traveling crane, which held them in position until they were securely bolted permanently. The weight of the caisson was then transferred from the blocking to the pair of ship ways, and, in order to protect the edges of the working chamber walls and the bulkheads from violent impact with the water, they were covered with temporary bottoms of longitudinal planks 3 inches thick reaching from bulkhead to bulkhead and from bulkhead to cutting edge. The planks were assembled loose, not bolted to the caissons, and were temporarily held in position by wire slings passing up through the interior of the caisson and made fast in the upper portion.

The caissons were launched on the ship ways by cutting through the two timbers that locked them into position. The inclination of the ways sufficed for the automatic launching without requiring the assistance of the two 75-ton jacks that had been provided for use if necessary.

Water rapidly entered through the false bottom, which was not intended to exclude it, and the bottom was promptly removed, after launching, by detaching the wire cables that held up the loose planks very much in the manner that a venetian shade is operated, and thus the planks were disengaged from their bearings, floated to the surface and recovered.

The building of the first caisson was executed with double shifts. It was towed with the tide 5 miles to position at the Pennsyvania side of the river at the foot of Race street, being handled by one tug in front and one on each side. It made the trip in about one hour, and was securely fastened to piers No. 7, 9 and 13, accurately locating it in the position in which it was sunk.

The two caissons are substantially duplicates and were successfully sunk in the same manner and by practically the same plant to bearing on solid rock at depths of approximately 60½ feet and 84½ feet, respectively. The Pennsylvania pier, known as Pier A, was built and launched before Pier B was commenced, and it was towed to position May 1; sinking was commenced by the deposition of concrete May 9 and was completed July 9. It is expected that Pier A will be completed about December 15, 1922. The caisson for Pier B was launched July 18.

The contract for the piers was awarded on December 27, 1921, to Holbrook, Cabot and Rollins.

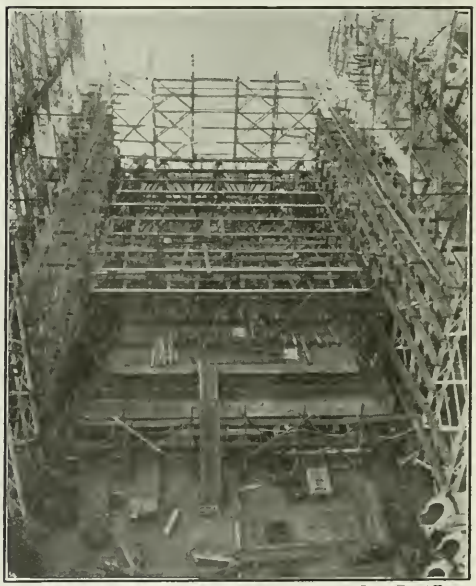
OLD COMMERCIAL PIER UTILIZED

The axis of the bridge is perpendicular to the bulkhead line, on which the river edge of Pier A is located at the foot of the existing Pier 11, which has been used for commercial purposes and will eventually be entirely removed to clear the bridge structure. During preliminary construction operations the pier has been utilized by the contractor for storage, office, shop and construction purposes, affording excellent provision for the delivery and installation of plant equipment and materials and shelter for the officers, men's quarters and some of the required supplies.

The pier was originally 60 feet wide and 540 feet long, with water 35 feet deep at the outer end. It was of pile construction covered by a wooden shed. About 60 feet of the river end was removed to clear the caisson, which was securely moored to it and to the ends of the adjacent piers 10 and 12. The river here is subject to an average tidal rise and fall of about 5 feet, and, as conditions did not require the construction of protecting works around the caisson, ample space was available in the slips and at the end of the pier for mooring scows, derrick boats and other floating equipment used in pier construction.

After removing the end of the pier shed and pulling the piles on which it was supported, the contractor removed about 20 feet more of the pier shed and an additional 40 feet of the pier roof, temporarily leaving the remainder of the building substantially intact, and affording space for the installation at the extreme end of the pier of two Ransome steel concrete hoisting towers 105 feet high, each of them equipped with a one-yard hoisting bucket, a vertically adjustable hopper, a steel boom 80 feet long, and a counter-weight truss 60 feet long supporting a steel chute 40 feet long connected with another chute supported by the boom and reaching to the concrete hopper.

Immediately in the rear of the hoisting towers

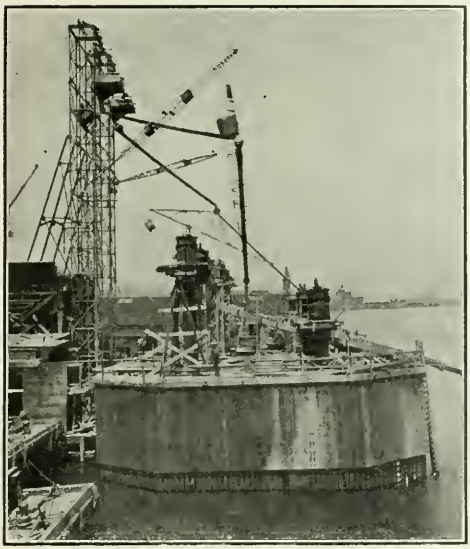


ASSEMBLING TRUSSES ON STEEL ROOF OF CAISSON.

were erected storage bins for aggregate, having a capacity which, because of the limited space available, was only about 200 yards. These bins were supported above the original roof level on wooden derricks mounted above the existing roof at the rear of the bins, and supported on timber towers built outside of the old shed, thus giving the derricks command of the storage bins and of the sand and stone barges brought alongside.

MIXING AND POWER PLANTS

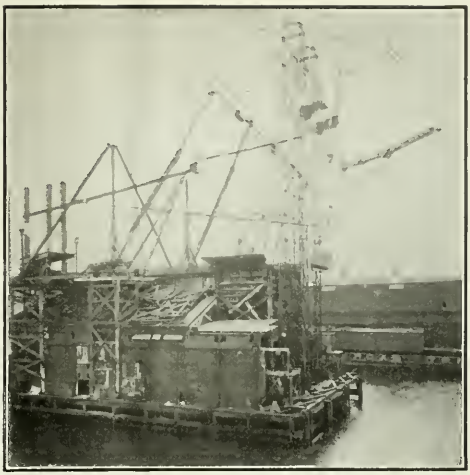
The mixing plant, consisting of two 32-foot Ransome machines, was installed directly under the storage bins, each supplied by gravity and discharging through a short chute into the buckets in the hoisting towers. Immediately adjacent to the mixing plant on the land side of the pier was located the 18x80-foot cement storage in which there is



SINKING AND CONCRETING CAISSON FOR PIER A.

maintained a liberal supply in bags delivered in trucks on the pier and transferred from the land end of the pier to the storage room by a long belt conveyor. Adjacent to the cement storage room is the power room, in which there are installed five straight line and one duplex Ingersoll-Rand air compressors with a united capacity of 5,500 cubic feet of free air per minute, which provide the low pressure air for the caisson and air at 100 pounds for operating pneumatic tools, and include three compressors held in reserve for emergencies or excess demand.

On account of the comparatively low pressure required it was not necessary to install any refrigerating device to cool the air in the working chamber. In the land end of the compressor room there was installed a battery of six 100-H.P. horizontal boilers with a 6-inch Cameron steam pump. Opposite the boiler room are the contractor's offices and rest



HOISTING TOWER, AGGREGATE STORAGE AND CONTRACTOR'S PLANT AT PIER 11.

rooms, and on the upper floor, over the air compressors and cement storage, are large lavatories and dressing rooms for the sand hogs, rest room, eleven shower baths, and the doctor's office and waiting room.

CAISSON SINKING

In sinking caisson A, the action of the tide at the end of Pier 11 forced the caisson about 12 inches out of plumb at the outset, but subsequent efforts reduced this amount to 9 inches when the caisson was landed on rock. When the caisson was first landed on the river bed, one end in soft mud sank about 3 feet deeper than the other end, but after the caisson was sealed and air pumped in the high end was sunk down to the same level as the low end, and uniform excavation was continued by the ordinary pick and shovel method, delivering the muck to cylindrical buckets at the foot of the material shafts, two in each compartment. The bucket lines ran through stuffing boxes in the tops of the Mattson material locks, and when the locks were opened the buckets tilted and dumped their contents through wooden chutes into dump scows alongside. The tops of the air locks were about 84 feet above the cutting edge on the shore side of the caisson and about 72 feet above the cutting edge on the river side, thus providing sufficient clearance for the required slope of the chute and clearance for the dump scows.

The caisson work was done by a total force of about 400 sand hogs in six-man gangs working 3-hour shifts with an interval of 3 hours between shifts, so that the work progressed continuously, each man working six hours out of twenty-four for a flat rate of $7.50 per day. The maximum progress was 28 inches in 24 hours, requiring the removal of 925 yards of sand and gravel. The caisson was sunk through mud, sand and gravel and 10 feet through loose rock, which was penetrated at the rate of about 9 inches in 24 hours, the rock being drilled

by a battery of 15 Ingersoll-Rand butterfly drills making holes from 3 to 16 feet deep and from 2½ to 5 feet apart, which were charged with 40 per cent Atlas dynamite.

CONCRETING

A gang of 14 men in all operated the concrete plant, which made a record of 599 five-yard batches in 12 hours. The concrete was hoisted to a height of about 86 feet and was deposited in the upper part of the caisson through 18x18-inch vertical wooden chutes with hopper tops into which the concrete was delivered through the swinging chutes.

After the excavation had been completed, the working chamber was filled with concrete delivered through the ten material shafts. Special concreting locks were placed on top of the material locks and both valves of the latter were left open to permit the rapid delivery of the concrete. The locations of the shafts were such as to permit the placing and flow of concrete by gravity and almost eliminated hand work in filling the working chamber, which was eventually sealed by grout forced in through a large number of pipes distributed over the entire area of the caisson so as to insure filling all voids left in the upper part of the concrete. After the working chamber had been filled, the refuge chamber or "tunnel" was filled with concrete deposited through eleven 12-inch vertical filling pipes arranged to command all parts of the interior and provide for the automatic deposition of the concrete without hand work in spreading. The upper portions of all the air shafts were sheeted in, to permit their removal after the lower part of the caisson had been completed, thus leaving wells which will eventually be concreted solid.

WELFARE AND SAFETY PROVISIONS

Although the maximum pressure in the working chamber of caisson A was only about 28½ pounds, great precautions were taken for the welfare of the sand hogs, which were so successful that no fatalities and very few serious cases of bends occurred. The lower ends of all air shafts were provided with hinged horizontal steel doors which were kept nearly closed when not in use; air was supplied through several independent mains, furnished by compressors operated by independent power supplies, and each main was provided with an automatic flap valve and a pressure regulating valve and pressure gauge.

The contractor provided comfortable and spacious resting rooms with individual lockers, hot and cold water and sanitation, in charge of an attendant, and supplied heat, light, ventilation and hot coffee for the men. He also maintained a separate hospital room for each pier, which was provided with a 6x24-foot field hospital lock having two compartments and with a capacity of about 12 men each. The locks were under the supervision of an experienced physician and the hospital was well equipped. All the compressed air employees were subject to examination and approval when they commenced work and every three months thereafter while working in the contractor's employ and after each return from an absence of one month or more. All employees in the compressed air were furnished with badges giving directions that in case of being stricken while off duty they were to be rushed to the hospital at the works rather than to a public hospital.

Aeration Experiments in England

The manager of the sewage works at Bury, England, J. Bolton, describes some experiments on aeration in the "Surveyor" of London. His article is abstracted as follows by Rudolph E. Thompson in the "Public Health Engineering Abstracts":

Preliminary settling and equalizing tanks are considered necessary for sewage containing trade wastes. The last tank put down by the corporation of Bury is dealing with tank effluent after nine hours' sedimentation. The tank is 24 feet in diameter, provided with a coned bottom, the depth to the bottom of the cone being 18 feet. An inner division is constructed of light timber, 19 feet in diameter, and carried 10.5 feet below top water level. The inner compartment, which has a capacity of 32,700 gallons, acts as the aerating chamber, and the outer chamber, with a capacity of 11,300 gallons, acts as a settling chamber. The center chamber is fitted with a cone provided with suitable vanes and an opening at the bottom. From the bottom of the cone, a trunk three feet in diameter leads to within six inches of the bottom of the tank. When the cone is set in motion, the liquid is thrown off at the periphery, and the mixture of sludge and liquid rushes up the center trunk to replace that displaced by the cone. As the liquid is thrown off from the cone, it is brought into contact with the atmosphere, and as it strikes the surface of the main body of liquid in the tank a large number of air bubbles are carried down into the liquid; by this means sufficient oxygen is taken up by the sludge to keep it in an active condition and bring about the required purification. The cone liquid strikes the surface of the tank liquid in such a manner that a circular motion is set up in the tank causing the sludge to descend in the form of a spiral, thus ensuring a longer contact and avoiding short circuits.

This system of combined aeration and settling tank has the advantage of saving the power required for re-circulating the sludge. One disadvantage, however, is that the operation of the tank has to be suspended for about 15 minutes daily to allow the surplus sludge to consolidate before being drawn off, otherwise a very watery sludge is obtained. The power used at present is less than 15-h.p. per million gallons per day. The following are average results of analyses, in grains per gallon:

	Settled Sewage	Effluent	Purification
Oxygen absorbed, 3 min.	1.34	0.30	77.6%
4 hours	3.98	0.71	82.2%
Ammonia—Free and Saline	2.10	1.60	23.8%
Albuminoid	0.52	0.09	82.7%
Chlorine	6.20	6.10	.....
Solids in suspension	3.20	traces	.....
Dissolved oxygen taken up in 5 days	...	0.63	.....

At times rapid changes take place in the character and bulk of the sludge. Sometimes an increase of over 5% in a day is obtained with the top portion of the sludge having a grayish cast. On such occasions, microscopic examination shows the sludge to be teeming with higher

forms of life, particularly vorticella, which appear in countless millions and at times come over with the effluent. When these conditions occur the sludge has a high water content. In ordinary practice, sludge has been drawn off with a water content as low as 97%, but when the sludge begins to increase in volume the water content is as high as 99%, and the nitrogen content of the dried sludge increases to as much as 8%.

Treatment of Sewage Sludge

How forty-three of the larger cities dispose of their sludge. Three sell it to farmers. Analyses of sludges classified by kind of tank used. Details of plants.

The nature and disposal of sewage sludges, as determined by a questionnaire of United States cities, was presented in a report before the American Society for Municipal Improvements and also before the American Public Health Association by committees of those two societies of which Langdon Pearse was chairman in each case.

Although an effort was made to obtain data from all towns of more than 1500 population, this was found impracticable and attention was concentrated on those having 25,000 population and more, and data are still lacking from a few of these. Sewage treatment works were found in seventeen cities of 100,000 population and up and in twenty-six cities of 25,000 to 100,000. The total population in the former group of cities was a little under 9 million, and in the second group of twenty-six cities was a little under 1¼ million. In addition to these, three cities coming in the former group and two in the latter have sewage treatment works under construction.

Answers to one inquiry were to the effect that of the group of larger cities practically no complaints are made against the operation of any of the plants except that of Baltimore, as regards either the plant itself or the disposal of sludge; while among the smaller cities, the Schenectady, New Britain, Fresno and Plainfield plants have been the cause of some complaint, and that at Austin before covering the tanks and trapping the sewer outlet, but no complaints have been caused by plants in the other cities.

DISPOSAL OF SLUDGE

Apparently all of the cities having air-dried sludge dump it on land, except Cleveland, Providence, Madison, Fresno, Mansfield and Plainfield. Only two, and those among the larger cities, have actually tried heat drying. Cleveland dumps liquid sludge into Lake Erie, while Providence dumps it at sea. The sludge is lagooned by Columbus, Worcester, San Antonio, Houston, Reading and Madison. Liquid sludge is plowed into the ground by Atlanta, Fresno, Fitchburg, Madison, Mansfield and Plainfield. Sludge is discharged into the river as opportunity offers by Columbus, Akron, Atlanta, Houston and Schenectady.

Removal of the sludge by farmers is reported by Philadelphia, Baltimore, Rochester, Columbus and Atlanta, and small amounts by Providence and Worcester. The same farmers have used sludge for several years in succession at Philadelphia, Rochester, Columbus and Atlanta, and to a certain extent at Baltimore and Worcester. Of these only Baltimore and Rochester report receiving money for the sludge, the former 25c per load and the latter 75c per load of two cubic yards. Baltimore, however, has received from $374 to $2,690 per year from the sale of sludge to a fertilizer company as well as to farmers. Of the smaller cities, Canton, Brockton, Lexington, Fitchburg, Pontiac and Mansfield report removal by farmers, and Allentown and Plainfield to a certain extent. The only one of these reporting sale of sludge is Pontiac, where two dollars per cubic yard is received. Plainfield reports that the sludge grows good corn, but its use is handicapped by the grease.

The analyses of the sludges were reported by a number of cities and the following are the averages of the figures reported:

Specific gravity, 1.03 for the larger cities and 1.02 for the smaller; figured on a dry basis, the larger cities show a moisture content of 87% and the smaller cities, 93%; voltatile matter, 46% in the larger cities and 45% in the smaller, and fixed matter, 54% in the larger and 55% in the smaller.

Nitrogen averages, 1.93 for the larger and 1.63 for the smaller, while ether soluble averages 8.4 for the larger and 8.2 for the smaller.

The above does not include the activated sludge plants, for which plants (those at Worcester and Houston), the specific gravity averages 1.03, moisture content 98.8, volatile matter 63 and fixed matter 37, nitrogen 5.5% and ether soluble 7.7%. The accompanying table gives the analyses of sludges received from the several sewage treatment works, all made on a dry basis in the laboratory of the Sanitary District of Chicago.

Analyses of Sludges Received from Sewage Treatment Works
All analyses on dry basis per cent.

Source of sludge	Nitrogen	Grease	Volatile matter (organic)	Fixed matter (inorganic)	Nitrogen in volatile matter
IMHOFF TANK					
Fitchburg, Mass.	1.71	4.6	35.3	64.7	4.84
Columbus, Ohio	2.04	5.5	45.7	54.3	4.46
Batavia, N. Y.	2.93	3.1	47.0	53.0	6.23
Plainfield, N. J.	2.91	4.1	50.7	49.3	5.74
Cleveland, Ohio	2.40	1.6	40.3	59.7	5.95
Atlanta, Ga.	1.37	4.8	34.1	65.9	4.02
Average	2.23	4.0	42.2	57.8	5.28
SECONDARY TANKS RECEIVING EFFLUENT OF SPRINKLING FILTERS					
Fitchburg, Mass.	2.25	4.6	43.4	56.6	5.18
Plainfield, N. J.	3.78	2.6	57.6	42.4	6.56
Average	3.02	3.6	50.5	49.5	5.87

CHEMICAL PRECIPITATION					
Worcester, Mass.	1.62	1.2	41.8	58.2	3.88
ACTIVATED SLUDGE					
(Sewage)					
Milwaukee, Wis.	5.82	2.2	67.8	32.2	8.58
Houston, Tex.	4.64	7.1	62.9	37.1	7.38
Average	5.23	4.6	65.3	34.7	7.98
(Industrial wastes)					
Argo, Corn Products.	6.03	1.2	75.3	24.7	8.00
Chicago, tannery wastes	2.18	0.2	49.4	50.6	4.41
Chicago, Stockyards testing station.....	4.17	6.0	62.6	37.4	6.66

NOTE: All these analyses were made in the laboratory of the Sanitary District of Chicago.

"The results of the inquiry show that the plants in the cities of 100,000 and upwards in general have technical attention and in most cases a chemist in charge, even though money is not always available for continued or complete operation. In the cities of from 25,000 to 100,000 only six have any complete control. Among the most thoroughly operated appear Fitchburg and Plainfield. The rest may have some control by a city official, but not enough to keep any real operating data. One city frankly reports no funds.

"From the standpoint of sludge disposal and use, the very great preponderance of air drying and dumping as a means of disposal is of note. Further, the lack of interest by farmers and the general lack of income as yet from sludge disposal are noteworthy. For this the low nitrogen content generally prevalent may be responsible. However, there is the possibility of lack of publicity. With suitable publicity one of the smaller towns within forty miles of Chicago has been selling its Imhoff sludge for several years at $5.00 per load. Chemical precipitation sludge appears to have practically no value.

"The obvious step necessary to interest the farmer in sludge is the development of a real yardstick of value. For this end the need of intelligent treatment on experimental farms is urged. At the suggestion of Mr. Hatton, the secretary of the U. S. Dept. of Agriculture has been requested by various municipalities to allocate part of the budget of his department for a thorough investigation, trying sludges in different parts of the country and in different crops. The experiment stations of the States of Illinois and Wisconsin have been urged by the Sanitary District of Chicago and the Milwaukee Sewerage Commission to cooperate. They have expressed a desire to do so within the limits of their resources. Further, the Sanitary District of Chicago is planning to undertake some experimental work in the vicinity of the truck farms around Chicago.

"In order to determine all the elements of value, trials extending over several years will be needed. Such trials to be effective necessarily must be quantitative. To properly apply the fertilizer and learn its true value, such trials should be under the direction of trained agricultural experts who know what fertilizers and what amounts are requisite for the different trial crops. Dr. Schreiner, of the Bureau of Soil Fertility of the U. S. Dept. of Agriculture, recommends trial crops typical respectively of roots, grain, leaf and fruit."

PLANT DETAILS

An inspection of the tabulated data shows that bar screens are used by twenty of the twenty-six plants in the group of larger cities and by eleven of the twenty-four plants of the smaller ones. Fine screens, two of 1/16" slots and one of 1/8" slots are found in three of the larger cities and four in the smaller. One mesh screen is recorded in the smaller cities.

In the matter of tanks, fourteen Imhoff tanks are found in the larger cities and twelve in the smaller; three activated sludge tanks in the larger; two septic tanks in the larger and two in the smaller; two sedimentation tanks in each group; one hydraulytic tank in the larger; one digestion tank in the smaller, and two chemical precipitation tanks in the larger. Filters are found for treating tank effluents in eleven plants of the larger cities and fourteen of the smaller; of these, trickling filters are found in ten of the larger and nine of the smaller; contact filters in one of the larger and two of the smaller; sand filters in two of the smaller and irrigation on land in one. In addition to these, one of the smaller cities has a plant for electrolytic treatment, one uses chlorination only in addition to fine screening, and one chlorinates Imhoff effluent.

Sewage Treatment at Johannesburg

The treatment of sewage at Johannesburg, Africa, contains a number of interesting features which are described by the city engineer, G. S. Burt-Andrews in "The Surveyor" of London for June 2nd. Some of the more interesting details are abstracted below.

The house sewage is carried in separate sewers, and in streets where there are storm sewers, these are placed above the sanitary sewers and in the same trench. Night soil from about 33,000 pail closets is dumped into the sewers which probably accounts for the unusual strength of the sewage. Comparing this with the sewage of the average English sewers, the suspended solids are more than seven times as high in parts per hundred thousand, the chlorine about two and one-half times as high and the nitrogen about three and one-half times.

The disposal plant consists of small silt basins or pits, coarse screens, large silt basins, four sedimentation tanks and an irrigation field.

In using the four sedimentation tanks the most satisfactory results have been obtained by operating the first two tanks in parallel and the second two in series. From the tanks the sewage flows upon an area of about 790 acres. A part of the farm has been underdrained for special use during wet weather. During dry weather, however, there is no visible effuent, which is accounted for by the high evaporation and the porous nature of the soil.

The sludge and screenings are removed by farmers to be used for fertilizer. Rye grass is grown on a considerable part of the irrigation

field with good success. Farmers are permitted to graze their cattle on the field, a charge being made of four pence per head per day. During 1921 the total amount obtained from this source was 3,141 pounds.

Study of Activated Sludge

A paper in the Journal of Industrial and Engineering Chemistry by John Arthur Wilson, William Copeland and Henry Mills Heisig, is abstracted as follows in "Public Health Engineering Abstracts":

Results are given of tests on activated sludge between October, 1920, and August, 1921, with hydrogen-ion concentration, temperature, septic action, and re-aeration. The optimum hydrogen-ion concentration for rapid filtration of sludge seems to be at about 3.2. The optimum temperature had not been definitely determined, but tests carried out at 22° C. showed better results than identical tests carried at 11° C., and 34° C. indicated that the optimum temperature lies between these latter two. Fresh sludge was filterable at considerably higher rates than septic sludge, regardless of hydrogen-ion concentration or temperature. Re-aeration of septic sludge materially improved its filterability. The temperature at which the best results seem to be obtainable would indicate that the action is due to bacteria than to enzymes. The addition of one-tenth per cent of aluminum sulfate reduced the time record for filtering sludge, and it was found that the optimum of hydrogen-ion concentration with aluminum sulfate was higher than without. The cost of treatment with aluminum sulfate, however, was found to be greater than that of aeration, with results not as good.

A Year's Operation of Direct Oxidation

Results obtained at the Allentown plant, as described by the city engineer. Cost of operation at full capacity of plant estimated from actual cost. No nuisance created, operation reliable, effluent stable.

The sewage treatment plant at Allentown, Pa., which uses the Landreth Electrolytic process called "Direct Oxidation" was described in the issue of "PUBLIC WORKS" for Oct. 8, 1921. The city engineer, Harry F. Bascom, read a paper before the American Society for Municipal Improvements in October, the title of which was "A General Review of One Year of Successful Operation of the Direct Oxidation Process of Sewage Disposal at Allentown, Pa." He first described the plant. This description it is not necessary for us to repeat, but the remaining part of his paper describing the results obtained was as follows:

During the past year the plant treated 73,000,000 gallons of sewage without the slightest evidence of nuisance or complaint and produced an effluent which was consistently and uniformly stable and of low bacterial count. The sewage is a normal sanitary sewage and its composition as well as the average composition of the effluent is shown in the following table:

Results of Sewage Treatment

	Raw Sewage P.P.M.	Effluent (1 hr. set) P.P.M.	Percent. Change
Suspended Solids			
Total	150	69	—54
Volatile	110	46	—58
Oxygen Consumed	17	8.1	—53
Free Ammonia	21	13	—33
Nitrogen			
Dissolved	10.4	7.7	—26
Total	24.0	14.6	—39.1
Chlorine	117.0	123.0	+ 5
Alkalinity (as CaCO3)	287.0	50 *	
Bacteria			
Total 37°C	2,036,000	12,000	—99.6
B. Coli.	87,000	18	—99.98

* Caustiefty aa CaO.

The sludge as removed from the sedimentation basin contains 94% moisture and amounts to 21 cubic yards per million gallons. After 4 to 6 days drying on the sludge beds in normal weather the volume shrinks to 11 cubic yards and the moisture content drops to 71%. Therefore, when dry the sludge will amount to about 3 cubic yards per million gallons.

It is interesting to note that the wet sludge as taken from the sedimentation basin was absolutely free of colon bacilli, contained 44,000 total bacteria and when diluted with river water and distilled water had a stability of over 99% with methylene blue in dilutions ranging from 1 to 25 up to 1 to 1,000.

During the year the sludge has in the main been satisfactorily used for filling around the plant, although in some instances truckers have carted it away and used it on their farms, and they report that it is a very good growth stimulant, soil corrector and improves the mechanical property of the soil.

Regarding the cost of operation, this will vary in different localities due to labor, the cost of power and to the hardness of the water supply. Allentown is unfortunate in this respect in that its water supply is well above the average in hardness and therefore requires much more lime than many other communities. However, during the past year accurate records of cost have been obtained and as the flow is continually increasing, these data have been computed and checked, and when the plant operates at full capacity or 3,000,000 gallons per day our figures show that the cost will be as shown in the accompanying table.

During the year several improvements have been made in the lime dosage, a new slaking

Cost of Operation per Million Gallons at Full Capacity of Plant (3 million gallons)

Power, 213 KWHr. @ 2.8c		$5.96
Lime, 0.6 ton	@ $9.10 per ton (86% CaO)...	5.46
Operators, $135; 2 @ $125; 1 @ $100 per mo.		
Labor—Laborers, 2 men @ 40c per hour		7.61
Heat		.08
Light		.17
Misc. supplies and repairs		1.02
		$20.30

Giving an operating cost of $20.30 per million gallons.

chamber was installed and the lime added further upstream from the electrolyzers, giving better slaking and mixing; also effecting a saving of approximately 25% in the quantity of lime used.

Lately a new type electrolyzer was installed and tested out showing a reduction of 50% in the hydraulic head required as well as an electrical efficiency considerably greater than the older type. This unit has the same effective electrode area as the older ones, but contains only a single row of 10 banks of electrodes and the agitators reciprocate instead of rotate, being driven from the top instead of the side.

Comment has been frequently made that the Direct Oxidation process is no more efficient than lime alone. In this connection a great number of tests have been made at Allentown both by the city chemist and by other investigators and the results are conclusively in favor of the Direct Oxidation process which gives an effluent that shows a greater reduction in oxygen demand, oxygen consumed, organic nitrogen and bacteria.

These tests also showed that the effluent produced by lime treatment, even though practically sterile when discharged, will putrefy if mixed with river water, while that from the Direct Oxidation process will stand up indefinitely. When we consider the experience of the British Royal Commission where litigation arising from nuisance has invariably followed from the installation of lime precipitating plants and also the findings of the Massachusetts State Board of Health, these comments are untenable for we have yet to encounter any nuisance at Allentown.

CONCLUSION

A very significant feature about the operation of the Direct Oxidation process is that it is mechanical in nature and depends for its success, not upon the delicate adjustment of conditions in an endeavor so far as possible to favor the caprices of bacterial life, but solely upon simple mechanical contrivances whereby lime is fed into the sewage in sufficient quantities to render that sewage always slightly but definitely caustic, and thereafter to maintain an uninterrupted charge of electric current in the electrolyzers. Outside of these features the process is automatic.

Except in the screen room, where the raw sewage passes over the screens, there is no odor of sewage, stability being obtained in the electrolyzing units without production of odor.

No odors are present outside the building, even from the sludge beds. Fly and mosquito nuisances such as are always prevalent at all other kinds of sewage disposal works are unknown at the Allentown plant. A system of this type can be located at any part of the city where favorable delivery of the sewage can be accomplished, and especially where little space is available. Long, expensive trunk lines and isolation of the plant are therefore unnecessary, a great saving in dollars to the municipality.

The plant operates irrespective of weather or temperature conditions, purification being accomplished without the aid of living organisms, and its operation is free from all uncertainties of bacterial activity, is not affected by climatic conditions or by changes in sewage, and is positive in action.

The variation in flow of sewage through the electrolyzers up to the capacity of the unit has no effect upon the current required; in other words, any quantity of sewage up to the capacity of the unit requires the same amount of current as the rated flow.

This paper was followed by considerable discussion, chiefly by Messrs. Fuller, Johnson and Eddy, the general tenor of which discussion is indicated in the description of the proceedings of the convention in this issue of "PUBLIC WORKS."

Sewer Maintenance

Experience with cleaning seven miles of 15 and 20-inch sewer. Roots, stones and sand caused serious obstruction.

By D. C. Newman Collins, M. Am. Soc. C. E.*

The question often presents itself as to whether engineers or municipalities devote as much attention to the overhauling of sewers as they do to their enlargement or construction and whether their value as a silent and unseen guardian of our health and comfort is fully appreciated. The construction of sewers has been recognized as an important specialty in engineering, much like road building, and yet the road engineer does not stop at the completion of a road but uses his best effort to study and support its efficiency under abuse and hardship. Good road service is a product of good construction and of constant supervision and maintenance, the importance of each having a direct bearing on its satisfactory and economic performance.

The construction of a sewer seems to be considered as a final achievement and its maintenance rarely goes beyond a partial removal of obstructions which force themselves upon our notice, and even this is generally accepted as being an unavoidable offense that is expected to repeat itself while in reality the repetition is invited by indifference or inattention to its natural ills and lack of care of its special weakness.

* Township Engineer, Cranford, N. J.

SEWER CLEANING GANG AND HAND WINCH.

I venture to say that the maintenance of sewers is fully as important as that of roadways and their constructive economy will depend just as much on skillful upkeep as road construction will and perhaps to a much greater extent for there is no public property which suffers greater abuse than sewers and while they form one of the most expensive items in municipal development their failure is accepted as hard luck and they are apt to be condemned long before they reach their technical limit of capacity and very often for no fault of their own.

The writer has just completed a thorough job of cleaning the Cranford trunk sewer amounting to nearly seven miles of 15 and 20-inch vitrified pipe. The results are well worth while and the experience is interesting not only in the value of intimate acquaintance with its particular symptoms of disorder but also for its statistical value in regard to the behavior of old sewer lines.

It will not be possible within the limits of this article to go into detail very far, but in a general way to describe the benefits and to dwell upon the location of obstructions, some of which may be avoided in the construction of new sewers.

The Cranford trunk sewer was built in 1894 and during its 28 years of life has fulfilled its mission as well as most other sewers have. During the past ten years it has been considered as having reached its capacity with the accepted excuse that the increase in population together with leakage, etc., is a natural cause. For several years an intolerable condition of backing up sewage into houses and spouting manholes after rains has been growing to a point where a heavy rain causes a continuation of these conditions over a period of many days before the sewers empty to a normal flow. I might add that the sewers of Cranford were designed as sanitary sewers and were not expected to dispose of storm water.

The citizens have patiently awaited the development of a large joint trunk sewer to serve all municipalities in the Rahway Valley which is a very natural and necessary enterprise and should be pushed to an early completion. I would emphasize that the results of the work herein described cannot be considered as a substitute for the proposed trunk line nor that it in any way lessens the demand for it, but that it will protect the new trunk from an unfair burden of heavy obstructions and gives Cranford once more the full capacity of the old trunk until the new joint trunk is in service.

From general indications of stagnation of flow and lack of action in manholes, the writer concluded there must be something wrong. After working in several local spots with a special home-made outfit with good results, but no general improvement, he decided the only way to locate trouble definitely would be to clean every foot of the trunk from its outlet. This was done with two full sets of equipment and two crews of men working under one foreman. The work was done with hand winches and heavy steel buckets with steel cable, using a float and line where possible and sewer rods when necessary.

A few of the largest obstructions are shown in the photographs to illustrate the handicap under which the sewer has been working and from the character and size of them it is reasonable to suspect that some of them may have been obstructing the sewer for a long time if not since its original construction. Large boulders were removed, not from a manhole but from the center of the pipe between. It seems hardly likely that they could have been moved along by the sewage flow to the position in which they were found. The bunch of roots weighing nearly 60 pounds when first removed (and considerable of its bulk was lost in the operation) was so closely compacted as to indicate its being there for a long time. It was removed from a section about 30 feet below the street surface where only one hard maple tree existed nearby. This obstruction alone may have caused most of the sewer trouble.

ROOTS FROM 20-INCH PIPE 30 FEET BELOW STREET SURFACE.

STONES AND DIRT FROM FOREST AVENUE SEWER.

In numerous spots great quantities of gravel, cinders, broken stone and a small percentage of miscellaneous matter was removed, in several places amounting to two cubic yards from one length of sewer between manholes. It is interesting to note that many of the finer grades of material forming obstructions had collected below a manhole where the sewer changed direction and where the velocity of the flow was impeded by a right angle bend in the sewer.

Immediately upon starting the work a great improvement was reported in the vicinity although the trunk line had not been touched. This local work was done to break in the men before starting them on the outlet several miles from home. The work was carried on faithfully through every foot of sewer and records were made of the location of any unusual condition for future guidance. In a general way the straight runs of pipe were fairly clean although many obstructions such as gravel, stones, barrel staves, iron rods and other unexpected items were removed. In the main trunk very little fats and offensive material was found but in the smaller laterals in town a greater quantity of grease, roots, soap and lighter material was encountered and especially in front of an invert under brooks or river the lighter matter would float and solidify, leaving the liquids to run off below until it formed a solid plastic mass which gave serious trouble.

Masses of roots were cut out, leaking manholes existed, cracked manholes were repaired. In certain sections considerable quantities of clean sand were found, perhaps due to careless connections of house sewers and probably also due to the practice of draining cellars and sewer trenches into the sewer during construction. In some parts of the town where quicksand existed the collection of sand in the sewer was always found.

The cost of doing the work is trifling compared with the benefit to every citizen in the Township. The work itself yields a gratifying interest to an engineer as an accomplishment of great value for small expense. To the workmen it offers a speculative charm as to the uncertain productions of the unknown under-world, and an occasional stick-pin, ring, collar button, bracelet, towel or set of false teeth was usually received in a spirit of victory like a prize package or a big bag of fish; and while they may not all be exactly appropriate for personal use or adornment the element of humorous curiosity is aroused to an extent that removed any smell of monotony in the work.

To a student in sewer construction the intimate acquaintance with sewer action, its vulnerable spots, constructive faults, inaccessible details and the practical merit or demerit of any particular sewer design will assure a first hand knowledge sure to broaden any technical mind.

Unusual Sewer Construction at Fort Madison

Reconstruction made necessary by raising of water level in the Mississippi river, due to the Keokuk dam.

By L. B. Reynolds*

The city of Fort Madison has a population of twelve thousand and is situated in the southeast corner of Iowa, on the Mississippi river, twenty-four miles north of Keokuk. The city is built on flat and gently sloping ground between the river and the bluffs. It is nearly four miles in length and varies from one-third of a mile in width at the east end to a mile at the west end. The old portion of the city with the business district, penitentiary, and several industrial plants, is at the east end, and the newer residence section, with Santa Fe shops and tire factory, is at the west end.

Prior to the completion of the Keokuk dam, in 1913, the stage of the Mississippi river varied from 0 up to 16 feet, a stage of 12 feet being normal each spring, with an extreme stage of 16 feet once in twenty years. For two years after Lake Cooper, formed by the Keokuk dam, was filled, the stage at Fort Madison averaged 12 feet, but during later years the water level has been held at 14 to 16 feet.

Up to the time when the Keokuk dam was completed, only the old extreme eastern portion of the city was served by sewers. Storm sewers ranging in size from 18 to 36 inches were laid on all north and south streets and to these mains about thirty blocks of so-called "sanitary" sewers, ranging in size from eight to twelve inches, had been connected. These branch lines had been laid in a most haphazard manner, oftentimes sloping in both directions from the center

* Member of the firm of Burns & McDonnell Engineering Co., Kansas City, Mo.

of the block. An even more serious condition was the connection into these small sewers of lamphole inlets from alleys mostly unpaved. Shortly after the dam was built another small district in the central portion of the city was constructed with similar storm inlets into eight and ten-inch laterals, some of which, furthermore, were laid on flat grades. Records of size, grade, and depth were almost entirely lacking.

When the Keokuk dam was nearing completion, the Mississippi River Power Company reconstructed all the sewer outlets and raised them to elevation 12. These outlets were submerged after the lake was filled to the higher level and have given increasing trouble since, due to formation of deposits in the pipe below water. The city recognized that not only had the existing system been damaged by raising the water level, but that facilities for the future sewering of the city had been impaired, thereby imposing further construction difficulties and adding to the cost

In the summer of 1916 the city retained the firm of which the writer is a member to make a complete survey of the city and design a comprehensive and adequate sewer system and report to the city the additional cost of such a system due to the raised water level in the river.

A trunk sewer along the river's edge to collect the sewage from all the existing sewers was not favored due to its large size and expense along with the necessity of pumping all the sewage. An intercepting sewer to collect all the dry-weather flow was not favored due to the expense resulting from the necessity of pumping the entire flow and providing capacity for an actual flow during storm periods much in excess of the dry-weather flow. It was decided to separate the storm and domestic sewage into two systems, utilizing the existing mains as storm sewers, and the existing laterals wherever well-built and suitable in size and depth, as sanitary sewers, but without any inlets for storm water.

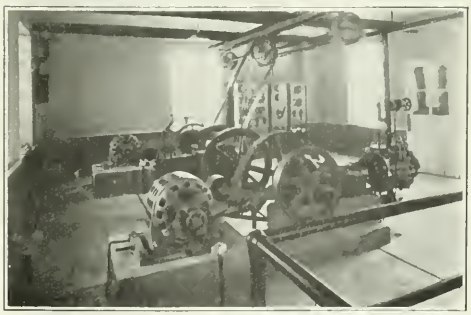
Surveys and plans for the new system were made by the writer during the summer of 1916. Due to the war conditions, construction of the sewer system was postponed until a new council was elected in the spring of 1919, on a sewer construction platform. Final surveys and plans were prepared and contract was let in June, 1920, to the National Constructon Company, of Davenport, Ia. Construction started in September, 1920, and the system was finally accepted by the city in August, 1922. The city eliminated the laterals in the extreme east portion of the city but retained the mains for serving this district. The system as constructed consists of eighteen miles of eight-inch to twenty-four-inch pipe and cost approximately $400,000. The Mississippi River Power Company, as a result of the report on damages, paid the city $50,000 toward the cost of the system.

The system is designed to provide basement drainage for the entire city. The sewage is all emptied untreated into the Mississippi river and the State Board of Health in approving the plans emphasized their belief that the United States Public Health Service, which would have jurisdiction over interstate streams, might and probably would at some future date, require treatment of the sewage before its discharge. This requirement governed the design to a considerable extent.

The new system has three gravity outlets serving the higher portions of the city and with outlet invert elevations above high water; also one pumping outlet serving the territory close to the river which is not high enough to be drained by gravity. The system is so designed that by the construction of two connections about twenty feet long and one twenty-two hundred feet long, the gravity outlets can be abandoned and all sewage turned into the pumping outlet; the pumping outlet is designed below these points for the ultimate flow after such connections are made.

Many difficulties were encountered during construction. All sewer pipe laid deeper than twelve feet was double strength; all three gravity outlets crossed railroad yards barely under the ties, where Class "D" cast iron pipe was used for considerable distances. Ordinary soil, dry flowing sand, quicksand and water-bearing gravel were encountered. The greatest difficulty was encountered on the pumping outlet which started at a depth of eight feet below river level at the pumping station and was laid through a gravel and sand formation with occasional stretches of quicksand. The contractor was protected in this work by a clause allowing him the cost of pumping and extra cost of sheeting and bracing necessary, and this extra amounted to over $35,000.

The sewage pumping station is located close to the river and the pumping equipment consists of three 150-gallon per minute pneumatic ejectors. The ejector pit is located in one end of the building with the motor-driven air compressors and emergency gasoline engine under the same roof. The construction of the pit was difficult, due to its depth below water level in the river, the bottom being about fifteen feet below in a gravel formation. The walls and floor of the pit were heavily reinforced and the walls were fifteen to twenty inches thick. The construction work was so well done that a match can be lit anywhere on the wall of the pit, due to the dryness of the walls.



INTERIOR OF SEWAGE EJECTOR STATION.

A. S. M. I. Convention*

Discussions of papers on sewerage and sewage treatment, street lighting, traffic and transportation, and refuse collection and disposal.

Thursday morning's session opened with the reading of a paper by Harrison P. Eddy entitled "Use and Abuse of Separate Systems of Sewers and Drains: Can Their Failure Be Prevented?" A written discussion of this was presented by Mr. Folwell, containing data on the subject which had been obtained some time previous through a questionnaire. (An abstract of this paper and discussion will be published in Public Works.)

The General Committee on Sewerage and Sanitation, Langdon Pearse chairman, presented a report containing data on a number of treatment plants, and a plea that urgent request be made to the Federal Government and others for a test by agricultural experts on the value of sludge as a fertilizer for growing root, stem, leaf, and fruit products, the experiment to include comparative tests of sludges from different processes used on various soils and under different climatic conditions.

T. Chalkly Hatton, chairman of the Sub-committee on Sewage Disposal, presented a paper entitled "Some Phases of Dewatering Activated Sludge at Milwaukee." He stated that that city had nearly reached the end of its investigation into the details of construction and operation of the activated sludge process. He reviewed the experiments that had been made in treating sludge by pressing, centrifuges, filters, separators and driers. Of all the appliances tried to date, the best results had been obtained by vacuum filters, experiments and tests with which were still going on. Presses and centrifuges, considerable hope of which had been entertained, had proved insufficient in the test conducted through 1921 and the early part of 1922. Tests are now being conducted with the Oliver vacuum filter. This works with a vacuum varying from eleven inches to twenty-two inches and produces a sludge with a moisture content varying from 72% to 78%. The sludge is raised to 160 degrees Fahrenheit by exhaust steam before being passed to the vacuum filter. Some of the processes which had previously been thought promising, while satisfactory under summer conditions did not prove to be so under winter conditions. Mr. Hatton referred to the experiment of the Maclachlan process which had recently been conducted in Houston with such promising results.

"Experiments in Centrifuging Sewage Sludge" was the title of a paper by H. B. Cleveland, chief engineer of the Barth Engineering & Sanitation Company. In this he described experiments that had been and are still being conducted at the Milwaukee and Baltimore sewage treatment plants. The company believes that it will shortly be able to offer an excellent appliance for treating sludge, though it has not yet reached a satisfactory development of the apparatus.

One of the most recent changes it has adopted is the introduction of a "drainage ring" in the apparatus at the Baltimore plant and this gives promises of being quite successful.

Statistical data concerning "The Value of Activated Sludge as a Fertilizer" was then presented by I. P. Kane, assistant engineer of the Sanitation District of Chicago.

In discussing these papers and reports T. C. Schaetzle, sewage treatment chemist of Baltimore, stated that at that plant the odors (which have caused considerable comment by visitors) were almost entirely from the raw sludge and that there was practically none from the digesting tanks when these were properly filled, and none from sludge dried upon sand beds. Part of the sludge is taken by a company that has a plant located on the sewage disposal grounds (see Public Works for March 25, 1922), and farmers take the balance of it, for which no charge is made. M. D. Tark, engineer of the Link Belt Company, said that it had been found that different sludges were adaptable to different soil and climatic conditions. C. M. Osborne believed that there was little hope of finding a sale for grease derived from sewage, as approximately 8% of such grease was unsaponifiable and no market could be found for such grease whether from sewage or garbage. He also expressed the opinion that all sludge sold for fertilizing purposes must be disposed of for local use, since the weight and bulk of the material and its comparatively low value made it impracticable to pay freight upon it.

The discussion of papers was interrupted at this point to permit the election of officers and selection of place of meeting and other business. The actions taken have already been reported elsewhere in this narration of the convention.

Following the business session, George W. Fuller gave a brief report and a paper (which had been published in the advance papers) entitled "Recent Developments in Sewage Treatment." This paper (an extensive abstract of which will be published in PUBLIC WORKS) gives the latest facts concerning skimming tanks, fine screening, separate sludge digesting tanks, Imhoff tanks, single-story tanks used in rotation, plain sedimentation with continuous sludge removal, contact beds, trickling filters, activated sludge process, sludge handling, final tanks, and finally the electrolytic or direct oxidation process. Discussion of the paper was confined chiefly to the last-named subject, following the reading by H. F. Bascom, city engineer of Allentown, of a description of a direct oxidation plant in that city, and the result of a year's operation of it. Mr. Fuller had described the process at some length and gave the claims of the proponents and opponents of the process. Col. George A. Johnson, who was not present, had sent a written discussion in which he expressed the highest opinion of this process as being always re-

*Continued from page 187.

liable because it is the only one that does not rely on bacterial action. Mr. Hatton stated that the sewage treated at Allentown was very weak and that therefore reliable general conclusions could not be drawn from this plant, but Mr. Moerk, engineer of the company controlling the direct oxidation patent, stated that the sewage was not weak but was as strong as that being treated at Worcester. Mr. Hatton also thought that the fact that the Allentown plant, though having a capacity of three million gallons, was treating only four hundred thousand to seven hundred thousand gallons per day, was an important factor in minimizing the value of the test. Also it seemed to him that adequate consideration had not been given to the disposal of the large amount of sludge that is being created. Harrison P. Eddy expressed the opinion that the cost of operating a direct oxidation plant was an important objection to its introduction. It is comparatively easy to bring taxpayers to the point of raising funds for constructing a sewage treatment plant but it is difficult to obtain funds later on for keeping it in proper operation. Consequently the most successful results are likely to be obtained by adoption of that plan which gives a minimum operating cost even though the construction cost might be higher. Moreover, while the direct oxidation process might produce a higher degree of purification than other processes, he believed it impracticable to endeavor at this time to attain ideals but thought actual progress would be attained by accepting a reasonable approximation to ideals. That the direct oxidation process was a proprietary one he considered no argument against it, since patented processes and appliances were used in all other branches of engineering. Mr. Fuller called attention to the fact that conditions as to lime demands by this process vary widely and that it consequently would be much less expensive to operate in some places than in others. Referring to the matter of sedimentation tanks, Glen D. Holmes stated that in tests made in Syracuse it was found that little additional precipitation was secured by reducing the velocity to flow through a sedimentation tank to less than 2½ feet per second, but it appeared that the percentage of precipitation depended almost entirely on the length of the detention period.

Mr. Bascom then read by title his report as chairman of the Sub-committee on Public Comfort Stations, the report having been published in the advance papers. It consisted chiefly of tabulated data concerning public comfort stations in the United States and Canada, sixty-nine cities having reported such stations, and a second table giving details of comfort stations in fifty-three Pennsylvania municipalities. Mr. Bascom was surprised to learn the small amount of interest taken in this subject by a large number of state engineers, which brought out all the more favorably the advanced stand taken by Pennsylvania, one illustration of which is the state law which permits counties to assist financially in the construction of comfort stations at county seats.

On Thursday afternoon the members and guests were driven to points of engineering interest in the city, the ride terminating at Nela Park, the headquarters of the National Lamp Works of the General Electric Company. Here there was a daylight inspection of street-lighting equipment, including different forms of lantern units and of standards, the latter being of various makes. At six o'clock a buffet dinner was given in one of the buildings in Nela Park, following which the evening program was held in the same room.

In opening the evening session a short address of welcome to Nela Park was given by R. W. Shenton, assistant manager of the Engineering Department of the National Lamp Works, who also presided at this session. In the absence of the chairman, C. W. Koiner, the report of the Committee on Street Lighting was presented by Earl A. Anderson, illuminating engineer of the Engineering Department of the National Lamp Works. In this report a general discussion was given of the latest tendencies in street lighting. It was stated that the lowest candle power that should be used for street lamps was 100, and that incandescent lamps were commercially available up to 2,500 c.p. For small lamps about three-quarters of the annual cost is for fixed charges, and, consequently, the additional cost of the brighter lights is only a slight percentage of the total cost. Ornamental lamps, which were formerly the exception, are now becoming standard for all street lighting. Reference was made to the new units designed for lighting highways, which are being adopted in several places. While cost is not the best unit for measuring effectiveness of street lighting, it has its value as a convenient one, and the cost for resident streets with fair to good illumination is found to vary from 20c to 80c per lineal foot of street, while for business streets it ranges between one dollar and four dollars.

This was followed by a paper entitled, "Modern Requirements in Street Lighting," by T. W. Rolph, street lighting engineer of the Holophane Glass Company. Mr. Rolph discussed the various requirements, not only of the lanterns and their glassware, but also of height, spacing, location, etc. He reported that very extensive tests had indicated that the minimum height at which a street lamp should be placed in order to avoid the objectionable features of glare is fifteen feet above the roadway, while greater heights are desirable for long spacing and where the branches of trees will permit.

"Interesting Features of Street Lighting Systems in Cleveland Suburbs" were described by A. E. Suker, street lighting specialist of the General Electric Company.

The meeting then adjourned to the museum of the company, where a very complete collection of types of lamps or other lights of all ages and countries had been collected. The ladies and other visitors not interested in the technical discussions had meantime been entertained by motion pictures, showing the history of lighting and of lamps, and a radio concert, which had

been arranged by L. C. Kent and O. F. Haas, of Nela Park. Just before adjourning for the night the company lighted for the first time a new 30,000-watt 60,000 candle-power incandescent tungsten lamp, the largest incandescent lamp ever constructed. This lamp, located on a low tower on the grounds of Nela Park, gave sufficient light to enable a panoramic photograph of the guests to be taken as they were grouped about the lamp at a radius of about 75 feet. This lamp had been constructed for moving picture work.

FRIDAY'S SESSION

The session of Friday morning was the final one of the convention. It opened with the report of Prof. A. H. Blanchard, as Secretary of the Committee on Standard Tests for Non-Bituminous Paving Materials. This committee recommended the adoption of fifteen tests which had been before the society for a year. It was decided to adopt the report tentatively until the 1923 convention, criticisms to be submitted to the Committee before July 1st of next year.

Prof. Blanchard then read his report, as chairman of the Committee on Traffic and Transportation, in which he presented, as a basis for traffic ordinances, a very complete assemblage of regulations as to both vehicular and pedestrian street traffic. In discussing this, Charles A. Mullen questioned whether the proposed regulations sufficiently protected the pedestrian in his legal rights, expressing the fear that it would place upon him the burden of proof in case of all accidents, but Prof. Blanchard stated there is no intention to do so except where the pedestrian was guilty of negligence or carlessness. Prof. Blanchard urged that the society become a member of the International Association of Road Congresses, which, at the present rate of exchange, would cost only about nine dollars, and the society voted to do so.

The next report was that of the General Committee on Street Cleaning, Refuse Disposal and Snow Removal, A. P. Folwell, chairman. The committee presented a report on "Refuse Collection and Disposal," giving statistics from about 150 cities and promising to prepare for publication in the proceedings a complete tabulation covering both collection and disposal in approximately double that number of cities.

Abstracts from a paper by Samuel S. Greeley entitled, "Modern Methods of Disposal of Garbage and Some of the Troubles Experienced in Their Use" were then read by M. N. Baker, Mr. Greeley having been called away a short time previous. This paper was quite an exhaustive discussion of the subject, based upon the author's most intimate acquaintance with it for several years past.

H. M. Farnsworth, president of the Metropolitan Park Board of Cleveland, then described briefly "The Park Systems of Metropolitan Cleveland," a paper which had been postponed from Monday evening.

The closing reports of the convention were those from representatives of the society in other organizations. Several of these had no reports to make, but brief reports were given from the representatives on the National Safety Council, the American Engineering Standards Committee, the Paving Brick Committee of the U. S. Dept. of Commerce, and the American Construction Council. After adopting the resolutions of thanks presented by the Committee on Resolutions, the convention adjourned.

Typhoid Fever and Water Supply

Some interesting statistics concerning water supplies and the effect of improvements in such supplies upon typhoid fever rates is contained in a paper by Langdon Pearse and S. L. Tolman dealing with the water supply and sewage disposal of the larger cities around the Great Lakes, presented before the American Public Health Association.

One of the tables gives the typhoid rate for all cities over 100,000 population from 1900 to 1920, inclusive, with the exception of a few cities where all of the figures are not available. These show a typhoid fever death rate per hundred thousand in 1900, varying from a minimum of 13 in Camden, N. J., to a maximum of 144 in Pittsburgh; while in 1920 the minimum rate was 0.7 for Paterson and the maximum was 14.9 in Birmingham. Not a city but had reduced its typhoid rate considerably.

In a number of cases the water is not purified at the present time, apparently not even by sterilization, so that a considerable part of the improvement was probably due to general sanitation and better conditions of milk and other foods used. For instance, in the case of Boston, for the years 1900 to 1908, inclusive, the typhoid death rate was above 20 every year but one, while during the years 1916 to 1920 it was below 3.7. On the other hand, a large part of the improvement in the case of Paterson, which uses water from the Passaic river which is filtered and sterilized, is probably due to such treatment; during the years 1900 to 1903 the rate ranged from 22 to 34, while since that time the range has been between 9.7 and 0.7. The best showing made is that by Pittsburgh. During 1900 to 1907, inclusive, the rate in that city varied from 107 to 144, while from 1909 to 1920 the range has been between 29 and 5.6.

In commenting upon the failure of some cities to lower their typhoid death rates by treatment of the water supply, this report states that "the use of dual water supplies in many of the industrial plants of the Calumet region may still be a possible source of typhoid. In such dual systems the use of polluted water is common." (It may be remembered by some of the older sanitary engineers that when filtration of the water supply was begun in Lawrence, but unfiltered water was also used in the mills for industrial purposes, in spite of warnings hung over faucets yielding the latter, the employees continued to use the unfiltered water and not until such use was discontinued did the typhoid death rate show a maximum decline.)

PUBLIC WORKS.

Published Monthly
at 243 W. 39th St., New York, N. Y.

S. W. HUME, President J. T. MORRIS, Treasurer

Subscription Rates
United States and Possessions, Mexico and Cuba $3.00 year
All other countries 4.00 year
Change of Address
Subscribers are requested to notify us promptly of change of address, giving both old and new addresses.

Telephone (New York): Bryant 9591
Western Office: Monadnock Block, Chicago
A. PRESCOTT FOLWELL, Editor

CONTENTS

DELAWARE RIVER BRIDGE PIERS. Illustrated.. 211
Aeration Experiments in England.... 216
TREATMENT OF SEWAGE SLUDGE.... 217
Sewage Treatment at Johannesburg.... 218
Study of Activated Sludge.... 219
A YEAR'S OPERATION OF DIRECT OXIDATION 219
SEWER MAINTENANCE. Illustrated. By D. C. Newman Collins 220
UNUSUAL SEWER CONSTRUCTION AT FORT MADISON. Illustrated. By L. B. Reynolds..... 222
A. S. M. I. CONVENTION.... 224
Typhoid Fever and Water Supply.... 226
EDITORIAL NOTES 227
Typhoid and Water Purification—The Government Sprinting Office—Advanced Pneumatic Caisson Practice.
Tight Sewer Pipe Joints.... 228
PREVENTING FIRES IN BRIDGE FLOORS. Illustrated 229
PREVENTING SCOUR AT BRIDGE ABUTMENTS. Illustrated. By O. H. Hempsch..... 229
Cemeteries and Ground Water Supplies.... 230
STREET DETAILS IN SAN FRANCISCO. Illustrated. By C. W. Geiger.... 230
Rubber Pavements 231
Traffic on a Tennessee Road. Illustrated.... 232
New Type of Highway Guards.... 232
Maintaining Wood-Block Paving in Peoria.... 232
Pennsylvania Highway Bridges.... 233
Gasoline Tax for Motor Vehicles.... 233
Black Base for a Chicago Boulevard.... 233
Concrete Sidewalks in Jacksonville.... 234
University of Michigan Highway Courses.... 234
Highway Magazines 234
Economical Subway Construction in Rochester.... 234
Illinois Changes Pavement Cross-Section.... 235
Sand Filter at Chester, England.... 235
Water Bills in Boston.... 235
PIPE LAYING IN NEW BEDFORD. Illustrated... 236
Water Supply for Parkersburg.... 237
Hydraulicking Earth in Rhode Island.... 238
Niagara Falls Power Tunnel.... 238
ELECTRIC PUMPING AT CONCORD. Illustrated. By P. R. Sanders.... 238
COPPER SULPHATE IN HARTFORD WATER SUPPLY 240
Gas in Street Manholes.... 241
Core Walls in Earth Dams.... 241
STREET LIGHTING CONSTRUCTION AND APPARATUS. Illustrated 242
Day Labor in Public Work.... 243
CEMENT PIPE IN ALKALI SOILS.... 244
Handling Men by Cableway. Illustrated.... 245
Co-operation for Public Utilities.... 245
RECENT LEGAL DECISIONS.... 246

Typhoid and Water Purification

A careful inspection of the table presented by Mr. Pearse in his paper before the A. P. H. A. referred to elsewhere in this issue gives rise to questions and conjectures as to whether too much credit has been claimed for water purification as an agent in the reduction of typhoid death rates.

Of the sixty cities of 100,000 population listed in the table, seventeen are reported as using no method of purifying their water supplies. Twelve of these are surface water supplies and five are well supplies. The remaining 43 cities are reported as treating the water in some way, in most cases by filtration either with or without sterlization, but in seven instances with sterilization only.

One peculiar feature noted in grouping the figures in the above way is that in 1920 the rate for the cities giving the water no treatment was 3.24, while for the cities treating the water the average was 5.6, or 75% higher. For well water which is untreated, the average is still higher, being 8.0.

Another point which may have some significance is that during the twenty years the typhoid death rate in those cities now treating their water has been lowered 87.2%, while in those cities that do not now treat their water in any way the improvement has been 89.4%. In other words, although a considerable percentage of the cities that now treat their water have introduced this treatment during the past twenty years and thus reduced the death rate by 87%, the twelve cities that have not introduced any treatment of the water have made an even greater reduction. From this it might be argued that the reduction in the former case was not due at all to treatment of the water, but to other causes which operated in both classes of cities alike—possibly improvement in the milk and other food products as well as in general sanitation.

The fact that only five cities use untreated well water does not warrant drawing any general conclusions concerning such use, but there would seem to be some significance to the fact that none of these five had a death rate in 1920 below 6.7, which is higher than the majority of the cities using treated surface supplies and more than double the average of the cities using untreated surface supplies, and higher than any of these with one exception.

Undoubtedly too much weight should not be given to these figures without a serious consideration of the attendant conditions in each case. For instance, it will probably be found upon examination that in the twelve cases where there is no treatment the water is naturally so well protected from contamination that treatment is not vitally necessary; while in the majority of cities where the water is treated, this water is more or less highly polluted and without treatment would result in a death rate much higher than that which now obtains.

The fact remains, however, that the typhoid rate has been reduced more than 89% on the average in twelve cities without treating the

water supply, which would seem to be an almost positive proof that a considerable part of the improvement in typhoid conditions in American cities during the past twenty years has been due to causes other than the improvement of the water supplies.

The Government Sprinting Office

The United States is proud of the rapidity with which it equipped, trained and transported a million soldiers to Europe. It is too bad some of the energy that put that through can not continue to be available for use at home—in the Government Printing Office, for instance.

We have received a copy of a 200-page bulletin on Colorado Oil Shales, giving information obtained during the past two years' co-operative investigation of the U. S. Bureau of Mines and the State of Colorado, which is published by the State "that it might be available sooner than if printed by the Government Printing Office." Apparently about three months were consumed in publishing this report. As it takes from one to two years to get most reports of the Federal Departments through the Government Printing Office, this action by the State appears to have been worth while and very commendable.

But why can not the Federal Government do as well as a State Government?

Rochester Engineering Society's Publication

The Rochester Engineering Society has just published the first issue of a monthly which is intended to serve the Rochester engineers, architects and others whose intersts are closely allied to these, most of whom are now members of one or more of nine engineering societies in the city.

No name has yet been assigned to the magazine, which appears this month with a large question mark on the cover, but the Board of Governors is offering a five-dollar cash prize for a name which shall "have some originality and individuality and be one which will include within its scope all the kinds of members that should be included in the nine local societies which we aim to serve."

United States Engineering Positions Open

The U. S. Civil Service Commission announces open competitive examinations for junior engineer, junior physicist and junior technologist for the Bureau of Standards, for duty in Washington or elsewhere, at salaries from $1,200 to $1,500 a year. Examinations will be held on November 22nd.

The Commission also announces examination for computer in the Coast and Geodetic Survey for service in Washington, D. C., at $1,400 a year, and at Manila, P. I., at $2,000 a year. Examinations for this position will be held December 6th and 7th.

Tight Sewer Pipe Joints

Since publishing the editorial in our August number entitled, "TIGHT JOINTS IN SEWER PIPES," we have received a letter from E. H. Rogers, city engineer of Newton, Massachusetts, in which he states that for about five years past the city of Newton has used sand and sulphur as a sewer joint compound for pipe sewers and house connections exclusively, having laid 7½ miles of sanitary sewers and the same amount of house connections in that time. Mr. Rogers refers to the Journal of the Boston Society of Civil Engineers for February, 1918, in which is published a description by him of his use of this compound.

Prevention of Fire in Highway Bridges

Wooden Bridge Floors Liable to Fire. Recommendation of Committee as to Construction and Maintenance Calculated to Prevent Fire

During the hot, dry periods of summer, fires have been very frequent in the wooden floors of the steel bridges crossing the rivers in the city of Pittsburgh. During last summer on one bridge fires were a daily occurrence and not infrequently two or three fires occurred in one day. They have been of minor importance only because they were extinguished before the flames had obtained much headway.

In the city of Holyoke, according to the report of the Fire Commissioners for 1921, the department that year responded to 170 fires on the various bridges, 64 of these being in June alone. Following this month the number was greatly reduced by the sending of a sprinkler over the bridges frequently during the day. These fires were almost always the result of cigarette stubs.

The old Raritan river bridge at Perth Amboy, prior to 1922 was decked with closely laid planked flooring, and no fires are known by State Highway Engineer Wasser to have occurred, but this year the deck was replanked with heavier lumber laid with half-inch openings, and there have already been several small fires.

These illustrations, from three cities only, indicate the necessity for precautions in construction of wooden bridge floors to prevent their destruction by fire. A report on the subject has just been issued by a committee composed of George W. Booth, chief engineer of the National Board of Fire Underwriters; L. T. Ericson and C. M. Taylor, officials of two wood-preserving companies; D. F. Holtman and C. J. Hogue, officials of lumber manufacturers associations; F. E. Schmitt, of Engineering News-Record, and E. F. Kelley, of the U. S. Bureau of Public Roads; which report is based upon extensive correspond-

ence between the committee and city, county and state bridge engineers.

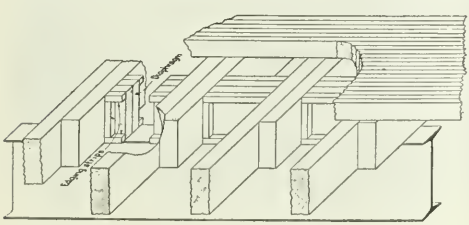
The committee finds fires most commonly caused by the lodgment of lighted cigars or cigarette stubs in cracks or depressions where chaff and debris have collected. Decayed or splintered material in the floor adds greatly to the fire risk. In the case of country bridges, the greatest risk is from forest and grass fires. Other causes are: Sparks from locomotives, hot coals from steam rollers or other construction equipment, burning waste from street-cars, defective insulation of electric wiring, and fire in adjacent structures.

Creosoted material appears to be somewhat more difficult to ignite than untreated, but once ignited it gives a fire that is hotter and more difficult to control. Freshly creosoted material is more inflammable than that several months old, and where such material is to be used for bridges it should be seasoned three to six months before use. In the case of freshly treated timber, the upper surface should be coated with sand.

In general, floors without open joints or cracks are most fire-resistent. The various types may be classified as follows in their order of resistance, beginning with those most resistent: Wood blocks on concrete base; wood blocks on planked sub-floor; laminated floor of 4 in to 8 in. strips laid on edge and spiked together, with a bituminous wearing surface; planked floor with bituminous wearing surface; laminated floor without wearing surface; multiple-thickness planked floor; single-thickness planked floor. In any case, steel joists supporting the floor reduce the risks of spread of fire. Where wooden joists are used, the fire risk will be reduced by using heavy timbers.

Special care should be exercised in designing the floor and its supporting structure to avoid ledges or pockets where trash may collect. In cases where such construction will not interfere with the proper disposal of floor drainage, curbs on timber floors should be constructed with ample clearance between curb and floor so that trash may have an opportunity to blow away.

Where stringers rest on floor beams, the spaces between them should be filled with tightly fitting diaphragms over each floor beam. These are preferable at least 6 inches thick and may be made of two thicknesses of plank spiked together. Battens should be placed around the edges of these diaphragms to cover cracks due to imperfect fitting or shrinkage. The accompanying sketch indicates the recommended construction.



FIRE STOP DIAPHRAGMS OVER FLOOR BEAMS.

In cases where limitation of head room is not a factor, fire curtains of sheet metal extending at least five feet below the bottom of the joists and spaced at intervals of about fifty feet will materially assist in preventing the spread of fire. Corrugated asbestos covered metal used for siding and roofing of buildings is suggested for this purpose.

In the matter of maintenance, the committee recommends that floors, ledges, pockets and bridge seats be kept free from street sweepings and other trash; that underbrush, small timber and other inflammable material be kept removed for some distance on both sides of the bridge, grass and weeds being cut in the early fall and driftwood removed immediately after floods. Chemical weed killers may be used to prevent heavy growth of vegetation. Frequent inspection should be made of any electrical conductors on the bridge. The floors should be kept free from sprintered and decayed wood.

Provision for fighting fire should be made in the form of water barrels, sand boxes or water pipes. Water can be prevented from evaporating by a light film of oil and from freezing by dissolving calcium chloride in it. Where water pipes are used, they should have hose connections every fifty feet and hose reels every 200 feet. In cold climates they must either be protected against freezing or be kept empty with provision for filling them when needed with water under pressure.

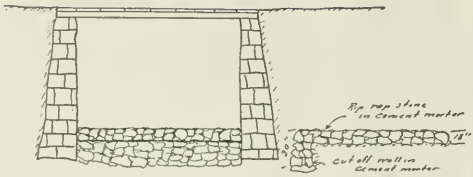
Maintenance of the under-structure and use of fire-fighting appliances will be facilitated by providing under the bridge floor, at points not more than 100 feet apart, platforms constructed of fire-resistive material, accessible by hatchways in the bridge deck or stairs on the outside. Where fire streams from hose and nozzles are available, there should be provided at 20-foot intervals, both longitudinally and horizontally, openings in the bridge deck to permit the use of cellar pipes, revolving nozzles or similar devices, these openings being not less than ten inches in diameter and provided with metal covers that can easily be removed but not readily displaced by accident.

Preventing Scour at Bridge Abutments

By O. H. Hampsch.*

The writer recently had occasion to repair a stone masonry bridge of approximately 16 feet span across a creek having a sandy loam bottom and which carried a very swift current that caused it to scour around both abutments. To prevent scouring, a floor was built across the bed of the stream 18 inches deep, of heavy riprap stone, hand-placed, with smaller stones wedged and tamped into place in the voids of the larger stone in the same manner as Telford base is built. Into this was poured a very wet mix of cement mortar, making it a monolitic mass. A cut-off wall 30 inches deep was

*Res. Engr., Tennessee State Highway Department.



SKETCH SHOWING STREAM BED PAVEMENT.

built on the upstream side across the face of this floor, as shown in the sketch, so as to prevent any current undermining this floor. In constructing this wall mortar was poured as wall was being built up.

A similiar cut-off wall on the down-stream side of the culvert would be desirable in many localities to prevent back-wash and undermining of the floor at this end.

This construction made a very satisfactory and economical repair, the cost being approximately $4.00 per cubic yard in place.

Cemeteries and Ground Water Supplies

In the latest report of the Department of Public Health of Massachusetts is an account of investigations made on the corrosion of pipes, the conclusion from which is that there is no reason to change the long-held opinion that "the active factor in corrosion is the acidity of the water, and this acidity is best ascertained by the determination of the carbonic acid present." Where the free carbonic acid exceeds seventeen parts per million corrosion may be caused, while if the amount is less there is little danger of trouble with brass, copper and iron pipes.

Analyses were made of large numbers of municipal water supplies and "in the course of this work it has been found that the presence of cemeteries upon the water sheds apparently had a direct effect upon the amount of carbonic acid present in the water supplies. For instance, in one of the cities of the state using ground water entirely and having a large area covered with driven wells, it was found that while carbonic acid was comparatively high in the water of all these wells, the higher amounts found were from the side of the driven well field on the edge of the water shed bordered by a continuous line of cemeteries laid out on sandy soil and extending for about half a mile in a line parallel with the well field."

Street Details in San Francisco

By C. W. Geiger

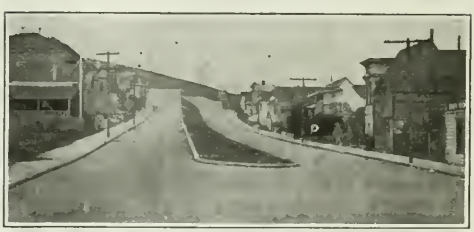
Special treatment for side-hill streets and streets too steep for vehicles; also for narrow roadways.

Some interesting methods of solving extreme grade conditions in the planning of streets in San Francisco are shown by the accompanying illustrations. Two of these show Quesada Avenue where one side of the street was considerable higher than the other at one end. At the beginning of this section the street is divided into two strips, an upper and a lower, each with its sidewalk and roadway. Each of these two strips is 22 feet wide and there is a 22-foot space between devoted to a sodded slope. At the far end the upper street is 14 feet higher than the lower. The lower street terminates in a dead end where there is a turning space, which is obtained by excavating into the slope of the hill and constructing a retaining wall surrounding this turning space. There are two stairways connecting the upper and lower levels. Asphalt pavement is used on the flat grades and concrete on the steeper ones.

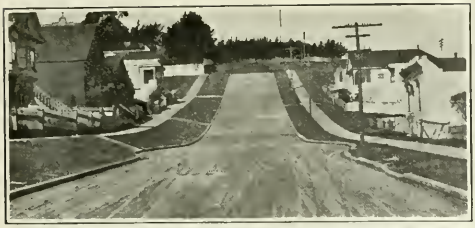
Another illustration shows a section of Revere Street where it passes through a district of low-value property which did not seem able to stand the expense of constructing a roadway wider than 30 feet. In order to permit automobiles to turn around, there was constructed in the middle of the block a turn-out or widened section of roadway which has a maximum diameter of 42 feet. The normal width of roadways is 50 feet and therefore this construction cost only sixty per-cent. as much as the normal width plus the additional cost for the turn-out. As there is not much travel in this district, no inconvenience is felt because of the narrowness of the street.

A number of streets in San Francisco are so steep that they cannot be used by vehicles and in some of such cases the city turns over the street to the property owners in the immediate vicinity to construct terraces and the like. One of these terraces is shown in the illustrations, that at Lyon street. One view, taken from the top, shows the elaborate concrete work and in

QUESADA AVENUE. TURNING SPACE AT END OF LOWER LEVEL.



QUESADA AVENUE, WHERE UPPER AND LOWER LEVELS DIVERGE.



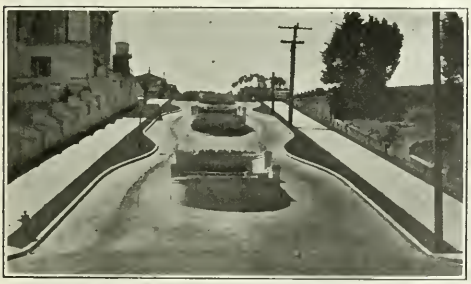
TURNOUT IN NARROW ROADWAY.
Thirty-foot roadway widened to forty-two feet in Revere Street.

the distance the Palace of Fine Arts and the California Building. Other instances of special treatment are shown in two other illustrations. One of these is practicable for automobiles and is used by demonstrators of automobiles to show the hill-climbing capacities of their cars.

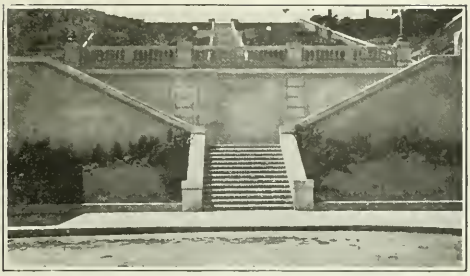
Another special construction on a hillside

STAIRWAY DOWN TERRACE.
Lyon Street, showing elaborate concrete work.

street shows a method of giving access from Jones street to Vallejo street, the latter of which is at a considerably higher level than the former at the intersection of the two.



TREATMENT OF ROADWAY ON STEEP HILLSIDE.
Used to demonstrate hill-climbing abilities of automobiles.



STAIRWAY UP TERRACE AT LYON STREET.

Rubber Pavements

The Department of Commerce, Washington, is authority for the statement that a rubber composition paving block has been produced by a London firm which, it is claimed, "can be placed on the market at a price to compete with the ordinary creosoted wooden block, when the advantages of absence from noise and long life,

SPECIAL CONSTRUCTION AT JUNCTION OF JONES AND VALLEJO STREETS.

estimated at 15 years, are taken into consideration."

Two types of blocks have been produced, one made with a core composed of a composition of rubber, jute and china clay, which is surfaced with a half-inch of hard vulcanized rubber, and another which consists of the core material only. In the first case the block can be vulcanized in one piece, which has been found to be necessary, since when a vulcanized block has been hollowed

MOUNTING BY WINDING ROADWAY AND STEPS.

out and filled with wood to reduce the cost it has been found that the rubber surface creeps and shows wear on the under side rather than on the surface. It is proposed to manufacture the blocks in sizes of 9x4½x3". Up to the present time it has not been found possible to manufacture these blocks at a cost less than three times that of wood paving blocks, or about $5.40 per square yard, and it is hoped that the price of paving will not be more than $13.35 per square yard.

Traffic on a Tennessee Road

An analysis of traffic on a Tennessee road has been made by Prof. N. W. Dougherty, of the University of Tennessee, in a brief article published in a Bulletin of the University of Tennessee. The traffic counts were taken by cooperation of the University of Tennessee, the Bureau of Public Roads, the Tennessee Highway Department and Davidson County. Counters were placed at thirty points, and forty separate counts were made.

On two of the main turnpikes a twenty-four-hour count was made, and the variation of traffic revealed by this count is shown in the accompanying figure. The total number of vehicles passing the stations in twenty-four hours was approximately 50% more than those passing the same station in the twelve hours between 6:00 A. M. and 6:00 P. M. The count was made in August, and toll roads in Williamson County showed that the traffic during August was approximately 50% higher than the average for the entire year. This appears to indicate that the average daily twelve-hour count in August is very nearly the average daily twenty-four-hour count for the entire year.

By a traffic census taken in 1916, it was found that there had been a small decrease in the number of horse-drawn vehicles, but the motor traffic had increased 420%.

A weighing station was established at one point, and by this was determined the rated capacity of each vehicle, the gross load in tons, the weight on the rear wheels, the tread of tire in inches, and load per one-inch width of tire.

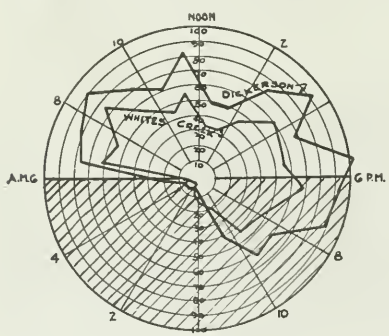


DIAGRAM SHOWING VARIATION OF TRAFFIC ON TWO TENNESSEE ROADS.

The rated capacity varied from one ton to 7½ tons, the vehicle with the former actually having a gross load of 2.79 tons and the latter 15.1 tons. Except the 7½-ton truck, most of the others had a gross load of 2½ to 3½ times the rated capacity. The load per inch width of tire varied from 645 lbs. for a 10-inch tire on a 3-ton brick truck, to 1,160 lbs. on a 2⅜-inch tire, this being a wagon carrying lumber.

Timing stations on a number of roads showed the average velocity of trucks to be 15 miles per hour, and of autos to be 24 miles per hour.

New Type of Highway Guards

A new type of guard for embankments and culverts on highways is being tried out in western Massachusetts by the State Highway Division. It consists of erecting a series of heavy posts, or concrete pyramids, five feet apart between centers along the edge of the embankment, although it is believed that seven-foot spacing would still prevent the passage of vehicles between them, and it is suggested that the distance could be still further increased to ten feet and the posts be joined by three-quarter-inch galvanized wire rope passed through eye bolts set in the tops.

The posts built in the test section are frustrums of pyramids twenty-four inches square at the base, twelve inches square at the top and equally battered on all four sides, and extending thirty inches out of the ground and twelve inches into the ground. It was thought best not to set them deeper and thus make them practically immovable, but yet to construct them so as to offer considerable resistance to overturning. The concrete is mixed 1:2:3:, in which are placed large stones, or plums, up to eight inches in size.

The forms are made so they can be easily removed and used repeatedly. The cost of this type of guard was about $3.50 per post, or 70c per lineal foot. Increase of spacing to seven feet would reduce the cost to 50c per lineal foot.

Where placed on concrete culverts, the posts are fastened to the culvert floor by dowels.

Maintaining Wood-Block Paving in Peoria

Peoria, Illinois, had had considerable trouble with the bulging of wood-block pavements laid about eleven years ago on its principal business street, which carries car tracks. For a number of years it has been necessary to make repairs after almost every heavy rain by cutting out the bulged sections and relaying the blocks. This year, Mr. Mortz, Commissioner of Public Works, has been doing more permanent work on this pavement.

Using a gang of about a dozen men he started at one end of the street to repair the pavement for the full length. First one side of the car track is put in condition and then the other side. Sections of pavement where there has been no heaving are not disturbed, but where the blocks have been displaced either by heaving or settling

they are removed and relaid. It is generally found that the sand cushion on which the blocks were laid has been displaced, apparently by water finding its way under the blocks, being piled into elevations in one point and washed into holes at others.

It is found on removing the blocks that only a little of the filler that was put in ten or eleven years ago remains adhering to the block, but that which does is removed. Where repairs are being made, the cushion is replaced with one of eight parts of coarse sand and one part of Tarvia B, which is mixed in an ordinary half-yard mixer and levelled off on the foundation for receiving the blocks. The blocks are then laid and the interstices filled with pitch, and coarse sand is thrown over the surface while the pitch is still hot.

Where the blocks are not taken up a coat of Tarvia B is spread over them and covered with sand. It is expected that this oil will add new life to the blocks and restore their imperviousness to moisture. Supt. Mortz believes that wood blocks should receive a coat of oil every two or three years to keep them impervious.

Pennsylvania Highway Bridges

As in most of the older states, the highways of Pennsylvania still contain at stream crossings a number of bridges of capacity both as to width and strength that is inadequate for present-day traffic. A survey recently made by the State Highway Department showed a total of 1834 bridges that are less than sixteen feet wide, many of them too narrow to permit two vehicles to pass. Plans are now being prepared to widen the more important ones as rapidly as the financial resources of the department will permit. The policy is to construct all new bridges with a width of at least 24 feet. In improving those which are not to be entirely rebuilt, the department will endeavor to retain the contour and general architectural characteristics of old structures which are landmarks in the communities where they are located.

Gasoline Tax for Motor Vehicles

Figures given for the first six months of 1922 by the Bureau of Public Roads of the U. S. Dept. of Agriculture show that seventeen of the States collected gasoline taxes as a method of providing funds for highway work. These States were Arizona, Arkansas, Colorado, Connecticut, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, Montana, New Mexico, North Carolina, Oregon, Pennsylvania, South Carolina and Washington. In Florida the tax was declared void in April. In all of these States the tax is one cent per gallon, we believe, except Oregon and South Carolina, where it is two cents. In Maryland a two-cent rate becomes effective January 1, 1923. In Arizona the total revenue from the gasoline tax was about 38% of that from registration fees, this being the maximum percentage; the minimum being about 8% in the case of Mississippi. The total gasoline tax for the six months for all the States is given as $5,510,846.

In the October 1 issue of the "News-Letter" of the Wyoming State Highway Department, the adoption of the gasoline tax for that State is advocated editorially. It is estimated that with a two-cent rate in Wyoming the gasoline tax would yield a revenue of between $270,000 and $300,000 for the year 1923. As it is estimated that $450,000 will be required annually for the next few years to properly maintain the highway system, this would result in the actual users of the road paying two-thirds of the cost in proportion to their use of it, while the remaining one-third would be paid by the taxpayers, which seemed to the department to be an equitable division.

The revenue from gasoline in States charging a one-cent tax averages about $4.50 per vehicle per annum. The total number of motor cars registered by July of this year throughout the country was 10,620,471. If a one-cent gasoline tax were applied in all States, therefore, the revenue so raised would apparently be between forty-five and fifty million dollars, plus the increase due to the continuous addition being made to the number of motor vehicles. Of this total registration for the country, slightly more than ten per cent. was motor trucks.

Black Base for a Chicago Boulevard

The West Chicago Park Commission is repaving Washington Boulevard from Halsted street to Ogden avenue, replacing an asphalt pavement which was laid in 1893. The roadway here is forty-eight feet wide. While nominally a boulevard, because of the fact that the streets intersecting the boulevard on opposite sides are not opposite each other but are staggered, heavy traffic using these intersecting streets must necessarily travel lengthwise of the boulevard in passing from streets on one side of it to those on the other. There are thirteen streets intersecting at intervals of about 330 feet, and the superintendent of the commission, William G. Barclay, reports that "The areas of the numerous intersections as well as those of parts of the roadway from which heavy or truck traffic cannot be barred . . . summed up, are probably 50% of the entire area, so that in effect the pavement will be subjected to a traffic similar to that on any business street nearby."

The old asphalt pavement had been laid upon a macadam base which had been greatly disturbed during the twenty-nine years since the pavement was laid, one corporation having made openings every twenty-five feet along the street and much repair and renewal work having been required on the underground structure during that period.

Supt. Barclay, in speaking of this improvement, said: "The Commissioners, knowing that additional materials were needed to provide a proper foundation, carefully considered the merits of portland cement concrete and black base. Their investigations of the bituminous type of foundation in several cities and the opinion of the engineers experienced in pavement construction convinced them that the

black base would be the better of the two. Being resilient, it absorbed some of the shock of impact of traffic, thus protecting both the wearing surface and the macadam base; the binder course could be eliminated, and the work would progress more rapidly, as no time would be lost as in waiting for a hydraulic concrete base to cure."

The boulevard is now being repaved with a standard two-inch sheet asphalt wearing surface upon a black base. Where the depth of base was more than 3½ inches it was laid in two courses. Standard Mexican asphalt is used in both base and wearing course, the amount of bitumen used in the former being 4.9% and in the latter 10.0%, the penetration of the asphalt cement being 41. The chief difference between the aggregates used in the base and in the wearing course respectively is that in the former the aggregates passing the 200, 80 and 40 mesh total about 17%, and about 80% in the wearing course; the base course containing about 28½% of ¾-inch stone, 24½% of ½-inch stone and about equal parts of 1-inch and ¼-inch material. The work is being done by the Commonwealth Improvement Company of Chicago, with William G. Foley as foreman in charge and Walter H. Flood & Company as chemical engineer. Supt. Barclay has general charge for the West Chicago Park Commission, and the Chicago Paving Laboratory makes the chemical inspection for the commission.

Concrete Sidewalks in Jacksonville

Jacksonville, Florida, years ago adopted regulations requiring that in certain sections of the city nothing but tile sidewalks should be laid. This is reported to have resulted from unfortunate experiences with concrete walks. It had not been practicable to have an inspector on each sidewalk and much poor work had been done, while the tile used for the walks could be tested by the city. City engineer Sheddan now favors constructing concrete sidewalks and prohibiting the laying of tile walks in front of business houses. It is reported that the ordinance will be so changed as to require a $500 bond for one year from every contractor building a sidewalk, conditional on his keeping the same in proper repair.

University of Michigan Highway Courses

The courses offered by the University of Michigan in Highway Engineering and Highway Transport have met with increasing approval by students of all classes and ages. In 1919-1920 the course was attended by 29 men, the next year by 45, and last year by 94. The average age of those in attendance last winter was 27, the youngest being 22 and the oldest 54. They came from national, state, county and municipal highway departments, from the offices of consulting engineers, contractors' organizations, university faculties, from companies manufacturing highway materials and machinery, and from the field of highway transport. Because of this growth in popularity, the Regents of the University have assigned for the purpose of these courses 26,000 feet of working space for the library, offices, lecture and drafting rooms, and laboratories in the new engineering building.

The course this year begins December 4 and continues until March 16; the week of February 12 to 16 being set aside for the Ninth Annual Michigan Conference on Highway Engineering.

Highway Magazines

Most of the State highway departments are now distributing bulletins of one kind or another throughout the state to keep the people informed of the work done by the department and secure the other advantages achieved by publicity. One of the latest of these is the "Montana Highway News," published by the Montana Highway Department, of which the seventh number has just been issued; this, however, being the first issue to be printed, the other six having been mimeographed and their circulation restricted to the employees of the department.

Says the "News": "The law requires and the interests of the taxpayers and road users demand that the people of the State be informed as to the status of state highway improvements and particularly as to the funds necessary and available therefor. In order, therefore, that this information may be provided economically and in convenient form, the Department will, for the time being, distribute monthly approximately 4,000 copies of the News."

Some of these highway bulletins are confined solely to figures and other information relative to work under way or contemplated, but the majority contain descriptions, generally illustrated, of construction work in different sections of the State, news items bearing more or less directly upon highway matters, and editorials calculated to present the doings of the Department in a favorable light and encourage the taxpayers to support good roads legislation. Many of them are well calculated to, and probably do, secure these things; but entirely aside from these advantages to the Department, the taxpayers are entitled to be given frequent and up-to-date information concerning the doings of a department which spends such a large part of the state and county taxes, and the publication of these bulletins would therefore seem to be amply justified.

Economical Subway Construction in Rochester

In constructing a subway for electric trains in the abandoned canal bed of the old Erie Canal in Rochester, N. Y., Scott Brothers, contractors, of Rome, N. Y., are securing economical results with the use of machinery. The bed of the canal, which is in rock, had to be enlarged, and the stone thus obtained was used for the concrete walls of the subway.

A Marion steam shovel loads the blasted rock into 5-ton trucks, twelve of which are used to carry it to the crusher, traveling in the canal bed. The crushed stone, sand and cement, in the proper proportions, are placed in Lakewood batch boxes, and

twelve of these are carried on a train of six small flat cars over industrial track by Plymouth dinkies to the mixer.

Here each box is dumped into the mixer as a batch. The mixed concrete is discharged into a tower bucket, and by this into a chute, which discharges it directly into the forms for the side walls of the subway, or onto the bottom or roof forms.

Illinois Changes Pavement Cross-Section

The following notice was sent, under date of October 23rd, to road contractors who were known to be interested in the construction of concrete roads for the Illinois Division of Highways.

To All Contractors.

The attention of all contractors who propose to bid on road work advertised for letting October 31st, or who propose to bid on work to be advertised at later dates, is called to the new cross-section for concrete pavements.

This cross-section provides for a thickness of nine inches, at the edges of the pavement, tapering to six inches at a distance of two feet from the edges. The remainder of the pavement is to have a uniform thickness of six inches. The amount and arrangement of reinforcement is to be the same as that heretofore used, with the exception of the center-joint material, a new design for which has been provided to correspond with the six-inch center thickness.

This new cross-section was adopted as a result of the Bates Road tests, which show conclusively that the strength of the edges of any rigid pavement, built in accordance with any design heretofore used, is much less than the strength of the interior portion of the slab.

The Bates tests disclosed the fact that a center thickness of six inches, or even perhaps five inches, is ample to support the legal load limit provided by Illinois statutes. The new cross-section takes advantage of this fact. The tests further indicate that even with a six-inch thickness for the main portion of the slab, a seven-inch edge with the three-quarter inch longitudinal bar would still not be as strong as the mid-portion of the slab. The edge thickness has, therefore, been increased.

Particular attention is called to the fact that the new cross-section provides one square foot less of cross-sectional area than a slab having a seven-inch uniform thickness. This means that the new cross-section will require 195½ cubic yards less of concrete per mile of pavement than the standard seven-inch design heretofore used.

The Department believes, therefore, that the new cross-section will provide a pavement which not only is better able to support trucks loaded to the legal limit, but will also reduce the cost per mile.

At first sight, it might seem that the cost of shaping the subgrade to accommodate the new cross-section would be troublesome. A little consideration, however, will indicate that the extra cost would be very small, as subgrading machines may easily be adapted to cut the subgrade to the new form. Even should the subgrade be cut to the usual crown, at an elevation six inches below the top of the forms and the dirt along the edges is then thrown out by hand, it may be seen that the additional cost of shaping the subgrade would be but a small item.

Contractors are earnestly requested to consider this new cross-section carefully, in order that we may cooperate as heretofore in building the best and the most durable roads with the least expense to the State of Illinois.

Very truly yours,
FRANK T. SHEETS,
Superintendent of Highways.
CLIFFORD OLDER,
Chief Highway Engineer.

Sand Filter at Chester, England

A novel feature of a slow-sand filter at Chester, England, is described briefly in a recent issue of the "Public Health Engineering Abstracts" of the U. S. Bureau of Public Health, being condensed from "The Surveyor" (England) for June 16.

The unusual feature of this filter is the fact that, while the top fifteen inches of sand in the bed is of such size that sixty per cent. is retained on a forty-mesh sieve, the twelve inches immediately below this is fine sand such that sixty-five per cent. is retained on a seventy-mesh sieve. Immediately under the fine sand is again fifteen inches of sand of the same size as that on top, under which is a layer of pebbles passing a quarter-inch mesh, resting on other pebbles passing a three-quarter-inch mesh.

"This form of filter has been in use for many years, and there is no doubt that the remarkable results obtained are due, in a great measure, to the action of this layer of fine sand. Sub-surface clogging takes place to a slight extent in the course of time, but this condition can be remedied by going down to the fine sand and removing a light scraping from its upper surface when replenishing the coarse sand removed by successive cleanings. There are practical reasons why the fine sand should not be placed on top, as the trampling it would receive in the course of cleanings would quickly reduce it to an impervious mass, and when removed to the sand washers, together with algae, mud and other debris, it would not be so readily dealt with as the coarse grade of sand." It is believed that by this fine sand the reduction of bacteria is made much more nearly complete. The rate of filtration varies from 0.75 to two gallons per square foot per hour.

Water Bills in Boston

In a recent issue of "PUBLIC WORKS" we called attention to a city which reported that all its water bills had been paid up to date. Apparently Boston is not nearly so fortunate or persistent in its collection, for Mayor Curley has announced that there are outstanding water bills in excess of $550,000, which have been accumulating since the year 1912, and he has requested the City Law Department to prepare a law for presentation to the Legislature making these water bills a lien on the property.

The shutting off of services, which was designed to compel payment of the bills and which has been carried on through the summer months, has brought in only $75,000, or about 12% of the total amount that was owing to the city in June.

The lien against the property that is contemplated by the proposed law will be similar to that applied in cases where taxes are owed the city on real estate. If demands for payment of the water bill remain unsatisfied, the city's lien on each property equal to the face of the unpaid bill will be sold to individuals, who will proceed to collect the bill in a manner in direct contrast to the leisurely way the city does that work.

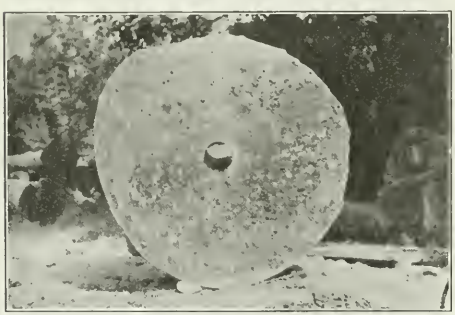
Pipe Laying in New Bedford

Steam Shovel and Derrick Used in Trenching and Laying Large Cast-Iron Pipe, and Lead Substitute for Making the Joints, with Great Saving in Cost

In the September issue of "PUBLIC WORKS" a description was given of the present condition of the old steel 48-inch main of the New Bedford water works, and reference was made incidentally to the laying of a new 48-inch cast-iron main. In a paper before the Convention of the New England Water Works' Association, Stephen H. Taylor, superintendent of the New Bedford Water Works, described the water system of that city and, in connection with this, the laying of this new cast iron main, which he described as follows:

"In 1920 the department had about 6,600 ft. of 36-in. main to lay in addition to the ordinary extensions, and as labor was scarce, it was decided to purchase a 14B Bucyrus steam shovel with an extended dipper arm for trenching, and in 1921, when the 48-in. main was started, a 14B Bucyrus "Clamshell" and derrick machine with a 30-ft. boom was purchased. These machines have proved great money savers on the large pipe work which has been done in the past three years. The latter machine is used for pipe laying, and in places where the ground is too soft to support the steam shovel over the trench, excavating is done with the clamshell outfit on the same machine. Under ordinary conditions the excavation is done by the steam shovel travelling on platforms over the trench with the derrick following close behind, laying the pipe. The shovel deposits the excavated material into trucks which haul it directly to the backfill close behind, or to the spoil bank.

"With reasonably good conditions, from 120 to 180 ft. of trenching, pipe-laying and backfilling per day is accomplished with a crew of from 15 to 20 men, two or three trucks, and the steam shovel and derrick. The advantage of a small crew is particularly great in our present work, which is ten to twelve miles from the city, and as there is very little local labor available the men must either be boarded near, or transported to and from the job."



PIECE CUT IN 1921 FROM 48-INCH STEEL MAIN IN SERVICE SINCE 1899.

In laying this new main, leadite has been and is being used. The reason for adopting this material and the experiences and experiments leading to this determination are described in the paper as follows:

EXPERIMENTS WITH SUBSTITUTES FOR LEAD

"Until within a comparatively few years water works engineers have been pretty unanimously of the opinion that the best if not the only satisfactory material for jointing cast-iron bell and spigot pipe was a good grade of soft pig lead, well caulked.

"During the past fifteen or twenty years various substitutes have been placed on the market and widely advertised throughout the water works field. The principal advantage claimed for these substitutes was the great saving of expense for both material and labor.

"The writer, like all good conservative water works officials, has hesitated to change from the established custom of using lead.

"Some ten years ago a few joints in the smaller sized pipe were made in the New Bedford water system with two of the substitutes,—Leadite and Lead-Hydro-Tite, and no trouble has ever been experienced from either.

"In the Spring of 1920, the writer decided to make some more extensive experiments with them. The city of New Bedford was then contemplating the laying of about 6,600 ft. of 36-in. pipe in addition to the usual yearly work, and as prices of everything were extremely high, any saving that could be made without decreasing the efficiency of the work was worth considering.

"At that time Leadite was offered at 12c. per pound and Lead-Hydro-Tite at 10c. while lead was selling for about 7½c. per pound. One pound of either substitute would fill as much joint space as four pounds of lead, so that it would take 30c. worth of lead to do the same work as 10c. worth of Hydro-Tite or 12c. worth of

SECTION OF 48-INCH CAST-IRON FORCE MAIN.

Leadite. There is also a further saving in the reduced labor cost, because no caulking is necessary, and the size of bell holes is greatly reduced. The only chance for skepticism, then, was as to their efficiency. As the contemplated work involved a considerable amount of jointing material, the two cents per pound difference in cost of Leadite and Hydro-Tite, was worth saving if the two materials were equally efficient. The experiments here described were made to determine this point as well as to determine their ability to stand high pressure, and the elasticity of the materials.

"The experiments were made with the assistance of Mr. W. R. Conard, engineer, Mr. Hays R. Kuhn, at that time employed by the Pennsylvania Water Co., who was familiar with handling Leadite, and Mr. Jacob Handy, superintendent of Dartmouth Water Works, who had considerable experience with Lead-Hydro-Tite. Mr. George McKay of the Leadite Company and several water works officials from nearby cities and towns were also present.

"*Experiment No.* 1. Six lengths of 6-in. pipe were put together on skids about two feet high in the pipe yard of the New Bedford Water Works, with a plug and sleeve on one end made up with lead and a patented plug in the other. Three joints were made of Leadite and three of Hydro-Tite. Dry white jute was used in its different forms, one joint with each material being made with loose yarn, one with the same yarn twisted lightly, and a third with the same yarn braided similar in appearance to packing, but without oil or grease.

"The pipes were first filled at city pressure (84 lb.) and the joints were all reasonably tight, the greatest leak occurring at the joint made of Leadite with loose yarn.

"There was also some leak at the joint made of Hydro-Tite with twisted yarn. The pressure was then raised, first to 150 lb. and then to 200 lb., all joints remaining reasonably tight and becoming entirely so with the exception of the two above mentioned. The high pressure was then released and normal yard pressure (84 lb.) maintained during the remainder of the test.

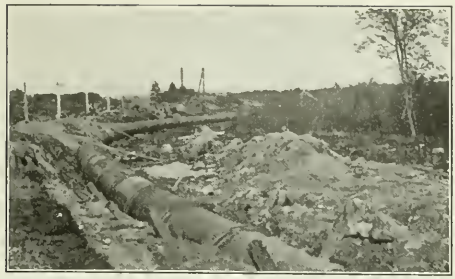
"The ends of the pipe were raised by means of a derrick at each end, the supports, which were under the pipe, being removed as the pipes were lifted from them until, for a short time, the line was practically suspended by the ends, forming a curve with about 144 ft. radius and the ends 5 ft. 9 in. higher than the center.

"Finally joint No. 5 of Hydro-Tite broke, allowing the center of the line to drop to the ground. It should be said, in fairness, that the joint which failed was not made with a continuous pouring, because some of the material was lost through a defective dam and a second pouring was necessary. Only a few seconds elapsed between the first and second pouring, however, as the kettle was close to the joint and it was only necessary to dip out more material.

"The whole line was then lowered to the ground and remained tight except the two joints before mentioned (No. 2 and No. 5). These were made tight by caulking with a little lead wool, and for several months the line remained in the yard in absolutely tight condition, in spite of the abuse to which it had been subjected.

"*Experiment No.* 2. As the principal work of the year was to be 36-in. pipe, it was thought advisable to experiment with this larger size to see if it could be successfully poured. Two lengths of 36-in. pipe were joined, with a plug in one bell and a sleeve and plug on the spigot end. Accidentally a class B pipe N. E. W. W. Assoc. specifications was placed into a class F bell. This made an unduly thick joint (about ⅞-in.). The class B bell was too small to receive the beaded end of the plug, so the plug was reversed. This made an abnormally thin joint with no bead, as the space was so small that it would have been impossible to caulk a lead joint. These joints were made with Leadite. On the other end the sleeve and plug were normal ½-in. joints and poured with lead Hydro-Tite.

"When the yard pressure was applied, in spite of the bracing at the ends, the joint between the two pipes slipped about ¾-in. This was the abnormally thick joint. The 84 lb. yard pressure on the 36-in. plugs developed a total stress on each of them of about 42½ tons.



LAYING 48-INCH CAST-IRON FORCE MAIN ON A CURVE WITH STRAIGHT PIPE.

"The braces were then removed and the pressure applied with the intention of pulling the work apart. When this was done the two abnormal joints made with Leadite held fast, and the one where the sleeve joined the pipe which was a normal ½-in. joint made with Hydro-Tite pulled apart.

"As a result of these tests, it was decided to adopt Leadite for our work, and it has been used in practically all the joints made since that time with excellent results.

"The story of this test would not be complete without further reference to the advantage of the braided jute packing, which we have also adopted for general use. We find that although it costs a little over twice as much per pound as the plain dry jute, the saving effected in labor and material more than offsets the extra cost, and that a better joint is obtained because there are no loose ends of the fiber to mix with the jointing material and reduce its efficiency.

"Since writing the above, a very favorable opportunity was presented for comparing the cost of 48-in. joints made of lead and Leadite, as two joints were made of lead on the check valves of our 48-in. line, because of the extreme weight of the casting and uncertainty of the ground in which it was placed.

"Figuring the cost of jute packing, labor and lead, a 48-in. joint cost $18.06; whereas the same items on Leadite joint cost an average of $4.42. It took three men one hour and forty minutes to pour and caulk a lead joint, whereas the same three men would average to pour from six to eight joints per hour with Leadite."

Water Supply for Parkersburg

Just about ten years ago the city of Parkersburg, West Virginia, put into service a water supply system by which the water was drawn from the Ohio river, being passed through a system of filters known as the "Smith System," the filters being laid in the bed of the river. This system was described in "MUNICIPAL JOURNAL" for February 15, 1917.

In a report to the city authorities, made about the 1st of October, E. A. Tisdale, sanitary engineer of the State Department of Health of West Virginia, stated that investigation showed that these filters have deteriorated to such an extent as to be no longer effective. "Muddy water, practically the same as the raw Ohio river water, has come through the filter beds into the city mains on numerous occasions during August and September, 1922. Also, bacteriological results of water tests, made by Dr. R. G. Lang, city chemist, shows the water has been unsafe for use at such times, despite the fact that a high dosage with chlorine gas has been maintained to disinfect the water. The time has come when Parkersburg must abandon the filter beds in the

river and turn to a more reliable system of obtaining a safe and satisfactory public water supply."

It seemed to Mr. Tisdale to be very probable that Parkersburg was wasting a great deal of water, the consumption being very high, and he recommended that a water-waste survey be conducted with a view to finding and stopping the leaks or waste. A supply of four million gallons would then be ample for some time to come.

He made no definite recommendation as to a new supply, except that careful investigation be made of the "gravel wall well filter system," proposed by the Lane & Bowler Company, which had offered to give a bond that they would produce the necessary quantity of water, and also that the cost of rapid sand filtration of the Ohio river water be investigated. The rapid sand filtration plant would cost about $120,000, he estimated, and the well system somewhat less. There was no question about the satisfactoriness of the former, and the only question about the latter appeared to be the certainty of a sufficient supply of underground water upon which to draw.

In 1908 Morris Knowles recommended obtaining a supply from wells, and in 1910 James H. Fuertes and George W. Fuller recommended filtering river water. The Smith filter was built upon the recommendation of Samuel M. Gray, made to the city in 1910.

Hydraulicking Earth in Rhode Island

The removal of large quantities of earth by the hydraulic method has become quite common in the West, but is rather unusual in the East. It is being used this fall in Providence, Rhode Island, for removing a hill containing about 55,000 cubic yards of earth to make room for a new industrial plant at what is known as "Fields Point" in that city. The pumps for furnishing the water are driven by two 75-H. P. electric motors, and in the first eighteen operating days excavated 30,000 cubic yards. The material is being washed into a marsh adjacent to the site.

Two nozzles are being used, each passing approximately 1½ million gallons of salt water per day with a nozzle pressure of 175 lbs. per square inch. The contract is being performed by the Briggs Engineering Company, which started work about Sept. 15th.

Niagara Falls Power Tunnel

It is reported that the new power tunnel being constructed for the Niagara Falls Power Company, together with the power plant, will be completed next May. The main 33-foot tunnel has been excavated its entire length and remains only to be lined. When this tunnel has been completed, water will be turned into it and use of the present hydraulic canal temporarily discontinued so that improvements may be carried on in this canal. The total cost of the work will be approximately $11,000,000.

Electric Pumping at Concord*

By P. R. Sanders †

Comparison of cost of electric with steam power at the same plant shows the former to be less than sixty per cent of the latter.

The water supply of Concord, N. H., is obtained from Penacook Lake, which is two and one-half miles long and one-half mile wide, located about three miles from the center of the city.

The overflow is at an elevation of 125 feet above the business section of the city. From 1872, when the system was installed, until 1892, the total supply was furnished by gravity alone.

As the growth of the residential section extended westward into the higher parts of the city, it became apparent that steps must be taken to provide an increased pressure. In order to secure this increased pressure, in 1892 a high-service system was installed, consisting of a 2,000,000-gallon reservoir at an elevation of two hundred feet, and a 2,000,000-gallon Worthington triple-expansion pump.

In addition to using this high-service supply for the higher section of the city, a 20-inch main was laid through Main street for fire protection only, directly connected to this system, and this has later been extended to other business sections.

The pumping station is located between the city and the lake, on the main pipe line, about one mile from the center of the city and two miles from the lake, and is supplied by gravity at static pressure of 50 lbs., from an 18-inch cement-lined main and a 20-inch cast-iron main, which also furnish the gravity supply for the city.

In 1904, when the village of Penacook, a part of the city six miles north, was added to the high service, a second Worthington triple-expansion pump was installed. Up to this time the daily average amount of water pumped was 400,000 gallons, but after the addition of Penacook, it increased to 800,000 gallons. The total daily consumption for all purposes is nearly 2,400,000 gallons, 800,000 gallons from the high service and 1,600,000 from the gravity service.

In 1917, when the United States entered the war and coal was needed for the manufacture of munitions and other war supplies, it seemed best after a thorough investigation of the matter, to release the quantity of coal used to run our plant and pump by electricity.

In this respect Concord is very favorably located, for power is manufactured by the Concord Electric Co. at its plant at Sewall's Falls, and the line is also tied in with the Manchester

* Paper before the New England Water Works Association.
† Superintendent of Water Works, Concord, N. H.

Traction Co. at Garvin's Falls, both of these plants being located on the Merrimack river.

A rate was made by the Concord Electric Co. to the Water Works, by which they were to furnish us power at 1 1/3c per k. w. h. After we had paid $1,800 there was to be no further charge until we had pumped 300,000,000 gallons and then the rate was to be $6 per million gallons pumped, figured on a yearly basis. All pumping was to be done at night, between the hours of 8 p. m. and 6 a. m., except in times of fire or other emergency when we could pump as required.

A contract was made with the Worthington Pump & Machinery Corporation for an 8-inch single-stage horizontal split-case, double suction, volute pump, to have an efficiency of 72% when pumping 2,100 gallons per minute or 3,000,000 per 24 hours, against a net operating head of 120 feet.

To drive this pump, we furnished an A. C. 100 h. p. General Electric motor of the squirrel cage type, to operate at a speed of 1,800 r. p. m., which was guaranteed by the makers to have an efficiency of 91.5% when operated at either full or three-quarters load. A 20x8 Venturi meter was placed on the discharge main. The pump was placed in service in August, 1919.

As the water is taken directly from the mains that supply the city, provision had to be made to take care of the water hammer caused by the shutting down of the pump, and a 4-inch relief valve was placed on the suction to discharge into the sewer, set at an overload of 20%. The pump operates against a check valve on the discharge side as it is not necessary to start against a closed gate.

No addition or new building was necessary as there was ample room in the existing engine room.

The steam pumps are kept for emergency and the fireman is released for other duties. A small heating apparatus was installed to heat the engine room, as it was considered too expensive to use the large steam boilers for that purpose.

A test of the pump was made for the month of September, 1919, with a daily average of 654,333 gallons pumped, 340 k. w. h. used, and a net head pumped against of 126.4 feet, and the pump showed an efficiency of 85.18%.

During the year, 1920, the record of the electric pump by Venturi meter measurement was:

Water pumped, gallons	308,879,000
Daily average pumped, gallons	843,931
Gallons pumped per minute 2,640, or 3,800,000 per 24 hours	
Total K. W. H. used	156,610.
K. W. H. per 1,000,000 gallons	506.
Static head, suction, lbs.	50
Static head, discharge, lbs.	88
Dynamic head, suction, lbs.	37
Dynamic head, discharge, lbs.	90
Net head pumped against, feet	122

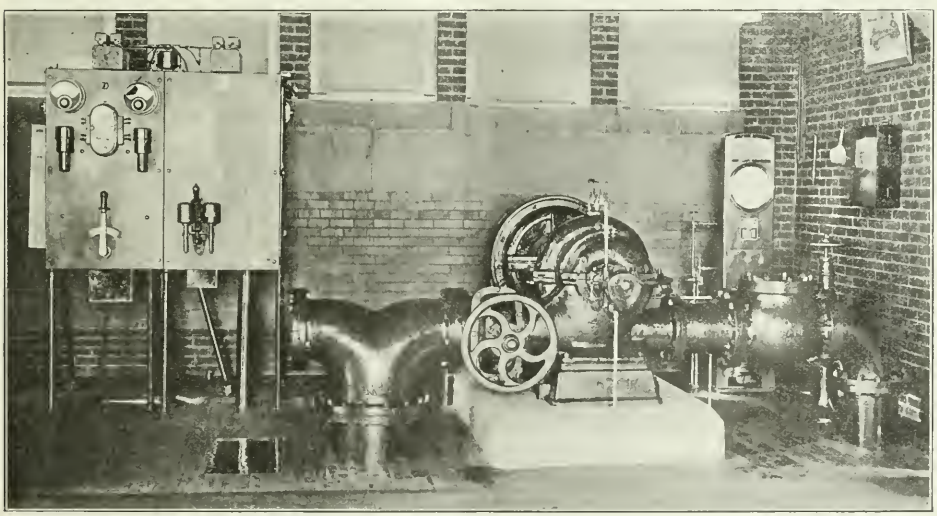
With switchboard loss of 2% and motor efficiency of 91½%, this gives an efficiency of 84.25%. The record for 1921 was equally good.

The cost of installation was as follows:

Centrifugal pump, foundations and fittings	$2,415.22
Motor and switchboard	1,291.50
Venturi meter	1,406.16
Heating apparatus	344.78
Total cost	$5,457.66

The supplies used for the past year were 14 gallons of oil, 47 pounds of packing, 74 pounds of waste and approximately 12 tons of coal to heat the building.

The cost of pumping by steam figured on total pumping station expenses with no allowance for interest or depreciation charges was:



ELECTRIC PUMP, CONCORD, N. H., WATER WORKS.

	per million gallons	
1911	$11.65	
1912	12.34	
1913	19.49	Excessive repairs
1914	13.12	
1915	14.02	
1916	15.40	
1917	16.22	
1918	17.06	
1919	15.14	Steam and electricity
Cost by electricity:		
1920	$13.16	per million gallons
1921	12.90	" " "

As wages and supplies were at least 33% higher in 1920 and 1921 than in 1918, it is fair to assume that the cost per 1,000,000 gallons pumped in those two years would have been $22.70, pumping by steam.

The total pumpage for 1920 and 1921 was 578,737,000 gallons which, if figured on the above basis, would present a saving of $5,590, by the change to electric power; and in addition, there is the advantage of the increased speed with which the pump can be started in case of fire.

Copper Sulphate in Hartford Water Supply

Experiences with its use for reducing algae in the reservoirs, resulting in lengthening filter runs. Methods of application.

The procedure and effect of applying copper sulphate to the reservoirs of the Hartford, Connecticut, water supply were described by J. G. Garrett, office engineer of the Hartford Board of Water Commissioners, in a paper before the convention of the New England Water Works Association.

Mr. Garrett stated that for several years copper sulphate had been applied to the various reservoirs of the system at seasons of the year when the micro-organisms became abundant, principally for the purpose of improving the taste and odor of the water.

Filtration was begun late in the Fall of 1921, and it was found that the use of copper sulphate lessened the amount of material which the filters have to remove from the water and thereby lengthened the duration of filter runs and, consequently, reduced the cost of operation. As a result of their experiences so far, the author believed that "presumedly we have not, as yet, got the whole story in regard to the amount of copper sulphate needed for effecting treatment, or in regard to the relation between number of micro-organisms and lengths of filter runs, but it is thought, from the information so far collected, that the application of copper sulphate has possibilities as an aid to economical filter operation with Hartford's water."

Hartford's older reservoirs are relatively small, and the copper sulphate has been applied to them by traversing them with a small boat equipped with an outboard motor, a bag of copper sulphate crystals being suspended over the side of the boat. The boat is rowed in a spiral course starting close to the shore and ending at the center, this course being determined wholly by experience and judgment. If, when the center is reached, it has been found that the pre-determined amount of sulphate has not been dissolved, an additional random course is followed with a view to spreading the remaining copper sulphate through the whole reservoir.

When it came to treating the large Nepaug reservoir, which required dissolving two tons or more of copper sulphate at a time, an eighteen-foot motor boat was employed. It was found by experiment that, with two bags of copper sulphate dragged through the water, one on each side of the boat, and the boat traveling at the rate of about six miles an hour, one hundred pounds of coarsely granulated copper sulphate would dissolve in five minutes. With this as a basis, it is possible to lay out courses over any portion of the reservoir which it is desired to treat so that the required amount of chemical can be dissolved in a more or less uniform manner. Ordinarily, courses are followed about 100 feet apart. The sulphate is well dispersed by the revolving of the boat propeller, which is one of the advantages of distribution by motor boat. Three men were carried in the motor boat, one to guide it and two to handle the sulphate bags. Since the sulphate dissolves much more rapidly when a bag is first immersed full, it was the practice to put a full new bag overboard on one side when the sulphate in the bag on the other side was about one-half dissolved.

The Nepaug reservoir was first treated on June 17, 1921. At that time the micro-organisms at the surface numbered 1300, and at a depth of thirty feet 350. Copper sulphate was applied to a part of the reservoir at the rate of 1.5 lbs. per million gallons. On June 21st, four days after treatment, the micro-organisms on the surface had been reduced to about 300. Some few small fish were found to have been killed by the treatment. There were certain coves in this reservoir which, in previous years, had been covered with a green algae scum, but none occurred in 1921 after the copper sulphate had been applied.

The new filters were started in operation in November, 1921, and until the middle of March, 1922, the number of micro-organisms did not average more than fifty, and the amount of water passed between scrapings was about 125,000,000 gallons per half-acre bed. Between March 17th and April 3rd high-colored bottom water was wasted from the Nepaug reservoir to prepare for the spring turnover, and water for the filters was meantime taken from the older reservoirs. The number of micro-organisms in these was somewhat higher than in the Nepaug, increasing to 185 by April 3rd. The rate of clogging during this short period indicated that the

quantity of this water that could be filtered between cleanings would average about 100,000,000 gallons per half-acre bed.

On April 3rd Nepaug water was again turned on to the filters, and by the end of the month the micro-organisms had increased to 150 or so, more than one-half being asterionella. Meantime, in the smaller reservoirs the micro-organisms had increased to 240 or 300, and they were treated with copper sulphate at the rate of 2.3 lbs. per million gallons early in May. Water meantime was being drawn from the Nepaug reservoir, and early in May this water began clogging the filters rapidly, runs of as little as 40 to 45 million gallons being the rule. On May 22nd Nepaug water was shut off so that the reservoir could be copper-sulphated, the number at that time totalling 300 at the surface and 200 at a depth of thirty feet. On May 23rd sulphate was applied to this reservoir at the rate of about 1.3 lbs. per million gallons, but produced no material results. The total organisms at the surface were not reduced at all in number, while those at thirty feet increased to about 600. About fifty per cent. of these organisms at this time were uroglena and thirty per cent. were asterionella.

Meantime the other reservoirs had been treated, and the micro-organisms fallen to between 50 and 100, and the filter runs lengthened to from sixty-five to seventy-five million gallons between washings.

As it was desired to use the Nepaug water as soon as possible, the same portion of the reservoir that had been treated before, that nearest to the intake, was again treated at the rate of about 2.3 lbs. per million gallons. Quite a few small fish were killed, but samples taken three days after treatment showed only slight reduction in the asterionella and practically none in the uroglena. The following day the micro-organisms at the surface were slightly less, but there had been a large increase at a depth of thirty feet, where they now averaged 1030 as against 600 on June 3rd. On June 9th Nepaug water was again turned on to the filters, being taken from the intake openings nearest the surface where the micro-organisms were lowest in number. On June 14th conditions had not improved, but by June 21st the surface counts had decreased to an average of 65 and an average of 100 at the 30-foot depth.

Certain other experiences during the summer were narrated by Mr. Garrett, some explainable and others not readily explainable. Apparently, as he stated in the quotation given above, there is yet considerable to be learned concerning copper sulphate treatment of micro-organisms in reservoirs.

Gas in Street Manholes

Gases of different kinds, mostly illuminating gas and that from gasoline, have been the cause of numerous accidents in the manholes of sewers and other underground structures, and a study of these gases is being made at the Pittsburgh, Pa., Experiment Station of the Bureau of Mines by S. H. Katz, assistant physical chemist and T. T. Bloomfield, junior analytical chemist. The aim is to determine the nature of the gases found in manholes and devise a practical test for determining the presence of them and means of preventing gas explosions.

Core Walls in Earth Dams

The Reclamation Service of the Department of the Interior has used several kinds of core walls and puddle cores in its dams. The walls are all of concrete, and are generally in comparatively thin sections. The highest in service at the present time is in the Strawberry dam in Utah, this core wall having a maximum height of about 70 feet above rock surface, or a total height of 85 feet above the bottom of the trench, the thickness varying from twelve inches at the top to a maximum of 48 inches at the bottom.

The Tieton dam, Yakima project, Washington, now under construction, will be the highest earth dam built by the Reclamation Service, being approximately 220 feet high. It will have both a concrete core wall and a hydraulic puddle core. The puddle core will have a maximum width of 70 feet at the base, and will be placed against the upstream face of the concrete core wall. The latter extends to a maximum depth of about 100 feet below the river bed, and will have a total height of about 320 feet. The foundation will be on andesite, except for a short length, which will rest on shale, this length having the footing spread out so as to limit the pressure due to the weight of the wall to eight tons per square foot, this footing being reinforced with 20-lb. rails spaced 12 inches centers. On the andesite foundation the maximum thickness will be five feet.

Only two dams have been constructed by the Service with puddle cores in the strict sense of the term, and these were constructed by hydraulicking, these being the Conconully dam and the Bumping Lake dam. The former has a puddle core eight feet thick at its base and five feet at the top, the height being about forty feet. The core in the Bumping Lake dam has a maximum height of sixty feet and widths varying from twenty feet near the bottom to two feet at the top.

Both these types of cores have proven adequately tight, and so far no trouble has developed due to saturation in the up-stream portions of the dams.

A most unusual core is that built by the Reclamation Service in the Sherburne Lakes dam as a means of draining the dam. It consists of a core of screened gravel ten feet thick at the bottom, about eighty-three feet high and five feet thick at the top, with side slopes of three in one hundred. This core is placed approximately under the down-stream edge of the crown and extends for the full length and height of the dam. The most impervious material in the dam is placed above the core, and the coarser below it. A cast-iron pipe with open joints is placed

in the bottom of the core and connects with transverse discharge drains, which lead the collected water into the stream. So far this construction has proven satisfactory, but it has not yet been thoroughly tested, as the water in the dam has reached only a head of forty-five feet, although it was designed for sixty-eight feet.

Street Lighting Construction and Apparatus*

By M. B. Hastings

Equipment necessary for both series and multiple systems, with underground or overhead construction. Control of lighting with time switches.

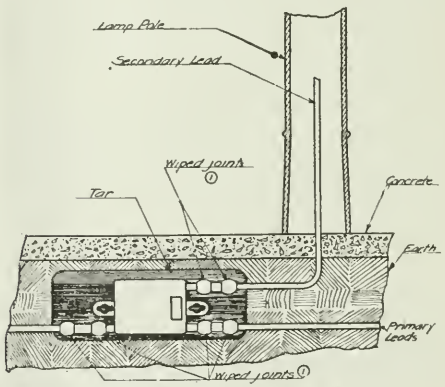
In general, street lighting is either series or multiple. In both systems the conductors are installed either underground or overhead. The overhead construction is most familiar and most common, although underground construction is best and is prohibited only on account of its cost. The cost can be very considerably lowered if foresight is used when the road is being made. Fibre conduit can be installed very cheaply if laid when the curb is being built. The one trench will do for both and in fact concrete equal to the volume of the conduit is saved.

The equipment necessary for a series system consists of a constant current transformer and panel board; or, an automatic constant current transformer. The cable of an underground series system should be No. 6 varnished cambric lead covered, with insulation depending on the voltage to ground. The voltage to ground depends entirely on the capacity of the constant current transformer and number of lamps in series. This cable is drawn through fibre conduit, imbedded in concrete, from one pillar to the next. Combination potheads and film cutouts were common, up to a few years ago; but now a series transformer at each pillar is considered best. By the use of a small series transformer at each pillar practically all the good points of both the series and multiple systems can be taken advantage of. The practice of mounting the series transformer in the base of the pillar has given way to that of burying it in the ground close to the pillar. So little trouble has been experienced with this type of construction that when the primary cable is properly jointed and wiped and the secondary leads are brought into the pillar, the series transformer is practically forgotten. A practical scheme is to make use of the packing boxes in which the series transformers come and fill with a cheap grade of pitch before permanently covering. Under operating conditions this gives a voltage on the pillar corresponding to the lamp in use, which is comparatively very low, approximately 25 volts in case of a 1000 candle power, 20 amp. lamp.

The series transformers have an efficiency of 93 plus per cent., a power factor slightly better than 98.5 per cent. and are made in almost any size desirable, although the standard sizes follow the standard lamp sizes. Where larger lamps are contemplated for future requirements, series transformers with a capacity greater than the immediate demands should be used. For instance the series transformers on the Sunnyside Boulevard in Toronto are capable of supplying 1000 candle power lamps, whereas the present installation consists of 600 candle power, 20 ampere lamps. This factor is an important one from the standpoint of lower efficiency lamps if such are ever obtainable. Where cheap current is available it seems unnatural to spend good money on high efficiency lamps to save that current. The intensity of illumination on the street should not be sacrificed and the ideal lamp for the purpose would be slightly increased in wattage to make up for the decrease in efficiency. The series transformer should have a capacity sufficient to take care of this.

The secondary of the series transformer should consist of No. 10, 600 volt, rubber insulated lead covered cable carried through an elbow conduit in the concrete base on which the pillar is mounted. The concrete base should consist of about ¾ of a yard of concrete for the ordinary sized pillar. Anchor bolts varying from ⅝-inch diameter in the case of the small park pillars, to ⅞-inch or 1-inch diameter in the case of the large white-way pillars should be used. The anchor bolts should be approximately 12 inches long, 8 inches of which should be in the concrete. The secondary lead covered leads of the series transformer should be long enough to reach the top of the pillar where they should be securely held independent of the socket.

In the case of Underground multiple systems, all the construction would be practically the same except the cable when 600 volt rubber insulated lead covered cable would be used. The leads to the lamp would be No. 10, 600 volt twin conductor weatherproof wire. The drop in



CONSTRUCTION AT FOOT OF LAMP POLE.

*Paper before Association of Municipal Electrical Utilities, slightly condensed.

voltage due to long runs of copper conductors is serious, and the size of the copper must be figured out accordingly. This is one of the disadvantages of the multiple system.

With either the multiple or series systems where crossings are encountered it is best to use a W.I. pipe and protect the end so water cannot get in and freeze. If the expense of lead cable in conduit is too great it is considered good practice to use steel armoured cable. In some multiple installations lead covered cable embedded only a few inches under the sidewalk and concreted in, has been used. The cable should be at least 12 inches underground and 6 inches where it is under a concrete sidewalk.

When overhead construction is used, the copper wires down the pole should be in conduit where possible. Up to 15 k.v.a. constant current transformers, where the secondary voltage does not exceed 2,500 volts, ¾-inch conduit should be used. Between 15 k.v.a. and 25 k.v.a. where the secondary voltage does not exceed 4,000 volts, 1-inch conduit should be used. Above 25 k.v.a. constant current transformers, the copper should be carried on pin type insulators. A distance of 9 inches from the pole is now advocated, so that the lineman need not come too near to it.

Protective devices are thoroughly recommended. Compression chamber multi-gap lightning arrestors are very good on the primary and the common horn gap lightning arrester is best on the secondary where the voltage is of an uncertain quantity.

We have dealt with methods of installations and protective devices and now let us discuss for a moment the control of a system. I am afraid time will not permit a discussion of the maintenance of a system, which after all largely depends on the engineer's personal attitude. Control of a system, however, is very important and it is essential that the predetermined schedule for the year be followed. This part of the patrolman's duties are generally neglected. Often as I go up and down the province I see street lights turned on long before time and still burning at eight or nine o'clock in the morning. Such is invariably the case when the system is not equipped with an automatic time switch. Even with time switches, the lighting schedule is not followed closely enough. The time switch should be set with respect to the schedule at least every week.

The Anderson electrically wound time switch is entirely automatic and will continue to operate as long as it is in good repair. It, however, has to be set periodically according to the lighting schedule. The electrical winding attachment is combined with a standard seven day clock, so there is no danger of the clock stopping on account of power being off for a few hours or days.

One of the most interesting developments in connection with automatic time switches is known as the season changing device for Anderson electrically operated switches. This is a great step forward in apparatus for controlling the time street lights are on, and a rather detailed description of this new device ought to be worth while and interesting.

When the time switch leaves the factory, the season-changing device has been adjusted for correct operation at the latitude where the switch is to be used, if known. Otherwise it is adjusted to the latitude of Boston—approximately 40 degrees north latitude. The latitude changing is done by lengthening or shortening of the cranks on the two small dials. This can be done by first loosening the center screws, when the cranks may be moved in or out, as required. This adjustment is difficult to accomplish, and should not be attempted in the field, but should be done before the switch leaves the factory.

After some time has elapsed between the date of shipment of switch and the time of putting the same in service, it will be necessary to adjust the season-changing device to the correct date when the switch is started to operate.

When correctly set, the instrument will follow the sunrise and sunset with a maximum error of about fifteen minutes from sunrise on August 15th and a similar error of fifteen minutes for sunset on May 15th, but will be practically correct on December 15th and June 15th.

Day Labor on Public Work

The Executive Board of the Associated General Contractors is interesting itself in the adoption by as many states as possible of legislation similar to that in force in Minnesota, which requires accurate and complete accounts of all public work or construction, to be open and available to the public.

This action has apparently originated in a belief by the contractors that a considerable amount of public work that is now being done by day labor should really be performed by the members of the Contractors Association, because it could be done at much less cost to the public in this way, and the belief that the public is not correctly informed as to the facts of the case. The Southern California Chapter of the A. G. C. reported that of 300 jobs done by day work in California, the cost could be determined of only five and on only two had bids been received from general contractors; while of these two, the cost in one had exceeded the low bid by 60% and in the other by 80%.

It was reported that in Illinois the law limiting the work done by day labor to $500 was evaded by splitting up the work into units, each having a cost of less than that amount, and the same is practiced in Utah.

The contractors believe that the public should know the exact cost of all public work done by force account and among the provisions of the law which they are advocating for passage by the different states are requirements that the estimated cost of each project be published at least fifteen days before the awarding of the contract, or the beginning of construction work where no contract is awarded; that bids should be received for every piece of work; that any

changes in plans or specifications during the construction be made public; that a time-limit be set on the time of publication of final costs; that the items included in the accounting fully cover the expense of equipment, depreciation, repairs, accounting, time of employees drawn from other departments, engineering and architectural service, and all other items connected with the work; and that the statement be audited by a certified public accountant and the actual cost published within ninety days after the substantial completion of the work.

Cement Pipe in Alkali Soils

Investigations made by U. S. Bureau of Standards show that best concrete will disintegrate under severe alkali attack.

The Bureau of Standards of the U. S. Department of Commerce has just published a progress report on investigations being made by it on the durability of cement drain tile and concrete in alkali soils. It is the result of inspection of experimental drain tile and concrete block installation at eight alkali projects in the west. The investigation was begun in 1913 and this report, although published only a few weeks ago, includes the investigations through 1920 only.

"The conclusions to date are that the best quality of concrete will disintegrate when exposed to severe alkali attack, and that installations of concrete in soils containing more than 0.1 per cent. of salts of the sulphate type should be preceded by an examination of surrounding conditions." The report contains tables and other details of the data obtained, together with illustrations showing the effect of alkali on cement pipe of different compositions and manufactured under various conditions.

In summing up the results, the investigators conclude that "durability of drain tile for any given concentration appears to vary with richness of mix and consistency. Hand-tamped tile are less resistant to action than machine-made tile made of the same mortars." "As a class it may be said that wet mix tile have been much less affected by alkali action than dry mix tile."

"Inspection of drain tile and structures in other localities where the alkali salts are of the chloride or carbonate types seem to justify the conclusion that these waters are not so severe as waters of the sulphate type which are found in all our drains in the alkali districts." Water flowing in drains very frequently has less acid concentration than that in soil surrounding the tiles. "In all cases where disintegration of the best quality of tile has occurred, samples of the soil immediately in contact with such tile have revealed concentrations much higher than are indicated by the drain water."

The investigating engineers have concluded that "the work to date has consistently emphasized certain precautions which should be observed by any one using cement under such conditions" (exposure to alkali soils and waters).

The conclusions from the investigations concerning cement drain tile are as follows:

1. The use of concrete tile in soils containing alkali salts of the sulphate type in considerable quantities is hazardous, in view of the fact that the best quality of drain tile has been disintegrated during an exposure of less than six years.

2. Porous or permeable tile, due to the use of lean mixtures, or relatively dry consistencies, are subject to disintegration in sulphate waters of relatively low concentrations.

3. Dense tile of the best quality, exposed to sulphate waters are under certain conditions subject to disintegration, depending upon concentration of salts in seepage water, and alkali and moisture conditions in the soil immediately surrounding the tile.

4. Disintegration may be manifested in sulphate waters by physical disruption caused by expansion resulting from the crystallization of salts in the pores, but it is primarily due to chemical action between the salts in solution and the constituents of the cement. In the case of dense tile of low permeability exposed to sulphate waters, disintegration may occur at or just inside the surface skin and progress into the wall of the tile.

5. A thin outer skin of apparently unaffected concrete is apparent in the case of disintegration of the best quality of tile. While this relatively thin layer may be either immune to attack by salts in solution, or perhaps be very slowly attacked, results indicate that this carbonized coating is not in itself waterproof, and alkali water may pass through this coating into the mass.

6. In sulphate waters with a concrete or mortar of given quality the disintegration effect seems to vary with the concentration of the solution.

7. Tile made by the process commonly used, which allows the removal of forms immediately after molding, are more susceptible to disintegration where exposed to sulphate soils or waters than are tile made of wetter consistency which requires their retention in the molds for a period of hours.

8. The use of hand tamped tile of plastic consistency, such that the jacket can be removed immediately after molding, can not be recommended for use in sulphate soils and waters. Tile of plastic consistency, molded in the packerhead type of machine, are more resistant to alkali action than the hand tamped tile, but the best quality of packer-head machine tile have been affected in waters of high salt concentration.

9. Steam cured tile show no greater resistance to alkali action than tile which are cured by systematic sprinkling with water.

10. Tile made of sand cement have less resistance to alkali action than tile made of Portland cement of the same proportions.

11. The tar coating as used was not effective in preventing the absorption of alkali water into the walls of the tile.

12. The cement-grout coating is not effective in preventing the absorption of alkali water.

13. No advantage was found in introducing ferrous sulphate into the cement mixture. The use of this material resulted in a reduction of the crushing strength of the tile.

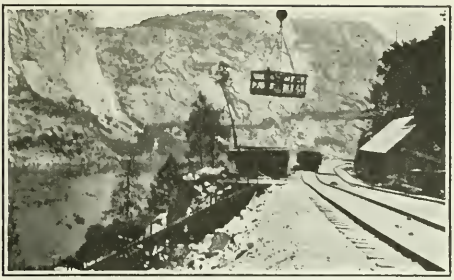
14. If cement drain tile are to be used in soils and waters containing 0.1 per cent or more salts of the sulphate type, their installation should be preceded by an examination of subsurface alkali conditions. Decision as to the advisability of using cement drain tile should be based upon thorough examination of subsurface conditions and quality of product which it is proposed to use, and upon a comparison of the data so obtained with the data presented in this report. Such an examination may indicate portions of an area where the use of cement tile should be avoided. Quantities

of alkali salt present can be determined by chemical analyses of the soils. Concentrations to which tile may be exposed can be determined by chemical analyses of the ground waters. In drawing conclusions allowance must be made for the constantly changing concentrations of alkali in the seepage water, which at times may differ as much as several hundred per cent in adjacent areas. There can be no assurance that the concentrations found at any time are the maximum to which the tile will ever be exposed. Quality of cement drain tile can best be measured by permeability tests. With other conditions equal, tile of lowest permeability will be the most durable. There appears to be little definite relation between permeability and the related factors of porosity, absorption, and density.

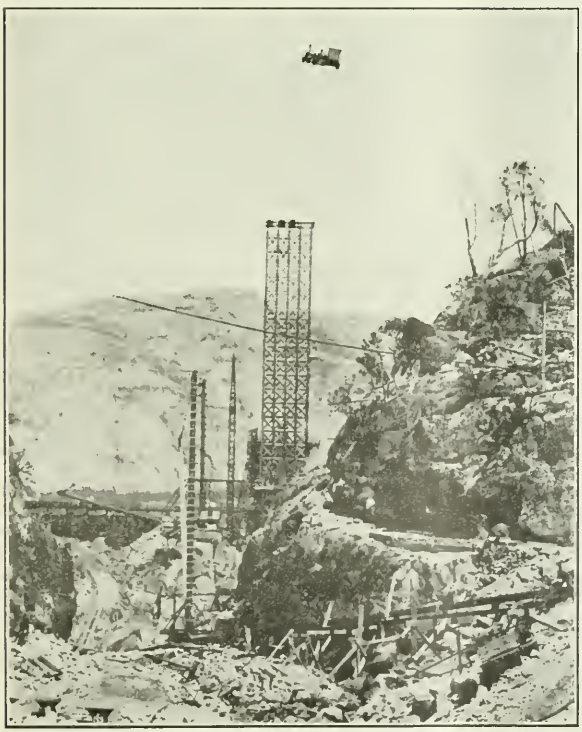
Handling Men by Cableway

In constructing the Hetch Hetchy dam for San Francisco the contractor, the Utah Construction Company, used inclined railways and steel derricks for removing the excavated materials, but later installed a Lidgerwood cableway for transferring material to the bottom of the foundation pit. (The dam and construction details have been described in Public Works for July 22 and earlier issues.)

The contractor established a camp about a quarter of a mile from the dam site and 500 feet above the bottom of the foundation pit. At the beginning of operations the men descended into the pit in a car operated on an incline by a hoisting engine. Later this was replaced by a cableway and trolley hoist with a skip carrying 40 men that could make one trip in three minutes. The same cableway was used for lowering an 18-ton locomotive from the tracks of the Hetch Hetchy railroad to the level of the stream bed.



CAR SUSPENDED FROM CABLEWAY TROLLEY TO LOWER 40 MEN AT ONCE 500 FEET IN EXCAVATION.



LOWERING 18-TON LOCOMOTIVE FROM HIGH LEVEL TRACK TO 117-FOOT EXCAVATION BY CABLEWAY.

Cooperation for Public Utilities

California voters are asked to vote on a number of State measures, one of which is a bill that would authorize contracts between two or more municipalities for joint action in the acquisition, construction or operation of public utilities or other municipal affairs of common concern, and if bonded indebtedness is involved a two-thirds favorable vote is required. If the vote be favorable, the contract must then be approved or rejected by the Legislature in the same manner as charter amendments and would be subject to future amendment or termination by the vote of the communities participating. This measure is endorsed by the San Francisco Bureau of Governmental Research. It certainly does not appear to make too easy the co-operation of municipalities in carrying out public utilities.

A charter amendment, which is also endorsed by the bureau, is one that would permit the expenditure of money by San Francisco for highways outside the city and county when they are authorized by the county, the funds to be expended by a duly constituted body authorized to construct the highway. While this would be a general provision, it is intended especially to provide for a proposed highway to be constructed by a joint district commission authorized by the state law.

Recent Legal Decisions

PUBLIC WORKS CONTRACTS AWARDED IN FRACTIONS ACCORDING TO GROUPING OF BIDS

Under a statute providing for written contracts for public works with the lowest and best bidder after advertisement, the Circuit Court of Appeals, Sixth Circuit, holds, O'Reilly v. City of Cambridge, 279 Fed. 961, that where it is contemplated that the contract would be awarded in fractions according to discretionary grouping of the fractional bids, the right of the director of public service to reject any and all bids gives him the right to accept part and reject part of one bid, provided that it does not result in the separation of items which are necessarily associated. If the successful bidder upon most of the items is awarded the contract upon condition that he will also assume an item upon which he did not bid, and will do so at a price by which the city will not be prejudiced, every requirement intended for the safety of the city has been met by the public advertisement and the reception and consideration of all the bids made.

DUTY TO HAVE TEMPORARY SIDEWALK OBSTRUCTIONS LIGHTED

The Louisiana Supreme Court holds, Lemoine v. City of Alexandria, 92 So. 58, that cross ties placed over a mudhole in a sidewalk, presenting uneven surfaces to pedestrians, were obstructions to travel, even though they were in a sparsely populated district and were placed there by request of the immediate neighborhood; and it was the duty of the municipality to maintain sufficient light along the sidewalk to protect those using it.

CITY HELD UNAUTHORIZED TO MAKE UNCHANGEABLE RATES FOR SEWER COMPANY

Section 22 of the Alabama Constitution provides that "every grant or franchise, privilege, or immunity shall forever remain subject to revocation, alteration, or amendment." The Federal District Court for Alabama, M. D., holds, Opelika Sewer Co. v. City of Opelika, 280 Fed. 155, that under this provision the Legislature cannot authorize a municipal corporation to make a contract fixing unchangeable rates to be charged by public utilities. Where a sewer company was given a franchise to operate in a city for 30 years and to charge rates not in excess of specified amounts, and where it was shown that the rates were inadequate to afford a fair return upon the value of the company's property employed in the service, no dividend having ever been paid, the rates were held to be confiscatory and unenforceable.

COUNTY'S DUTY AS TO RETENTION OF PART OF CONTRACT PRICE TO SATISFY LIENS

The Washington Supreme Court holds, Aetna Casualty & Surety Co. v. Skagit County, 207 Pac. 237, that a county which pays out to the bank which financed the contractor the 20 per cent. of the contract price which the contract provided should be retained to satisfy liens without the consent of the bonding company and while other claims are unsettled, will be liable to the bonding company for the claims which could have been paid out of the fund. Where the contract provided that the contractor should show to the satisfaction of the county that all just debts due for labor and material had been paid, it was not sufficient compliance with this provision to make the final payment on the verbal statement of the contractor alone, without an investigation.

The Circuit Court of Appeals, Sixth Circuit, holds, O'Reilly v. City of Cambridge, 279 Fed. 961, that where proposals for bids provide that before final payment on the contract the contractor shall give bond for maintenance for a specified period, the omission from the contract for the work of a provision for such a bond does not dispense the necessity for giving it.

ISSUE OF COUNTY ROAD WARRANTS PAYABLE IN FUTURE HELD UNCONSTITUTIONAL

The Arkansas Supreme Court holds, A. L. Greenberg Iron Co. v. Wood, 240 S. W. 1074, that a county has no power to issue road warrants payable in the future, and a statute providing that a county may issue such warrants is unconstitutional. The object of this statute was to pay certain holders of county road warrants a sum equal to a stipulated rate of interest for their forbearance in presenting the warrants for payment. A warrant on the county for supplies cannot be issued until the county owes the debt and it is payable on demand. Such warrants are therefore subject to a county court order calling for outstanding warrants for cancellation and reissuance under the Arkansas statute providing therefor.

QUESTION OF ELECTION BY CITY OF OPTION TO PURCHASE WATERWORKS SYSTEM

Where a city had the right under its franchise to a water company, to purchase the system at the end of 20 years, the Circuit Court of Appeals, Eighth Circuit, holds, City of Wichita v. Wichita Water Co., 280 Fed. 770, that a resolution passed at the end of that time providing for the appointment of appraisers to value the system so that the proposition of purchase might be submitted to the vote of the citizens, and correspondence with the company on the subject, did not constitute a contract which the water company could have specifically enforced, the court being of opinion that the mayor and commissioners never intended on their own authority to purchase the system. The court distinguished the case of Castle Creek Water Co. v. City of Aspen, C. C. A., 146 Fed. 8, where there was such an arbitration clause in the water company's franchise, and where the city had actually given notice, one year in advance of the expiration of the franchise, as thereby required, of its intention to purchase the system.

COUNTY HELD NOT ENTITLED TO RECOVER BACK MONEY PAID FOR ROAD REPAIR MATERIAL IN EXCESS OF SPECIFICATIONS

A county entered into a contract, after advertisement for bids, for "approximately 50,000 gal-

lons of tar" for repair of a road. The specifications provided: "But in no case shall the total be increased or diminished more than 25 per cent. of the estimated amount required." 25,408 gallons in excess of the maximum amount so specified was used on the road, amounting to $4,509.92, under the direction of the supervisor of roads, without any additional advertisement or supplemental contract. The bill therefor was audited, approved and paid by the county, which subsequently sued to recover it back, on the ground that it was an illegal and void payment. The New Jersey Supreme Court holds, Mercer County v. Tobish, 117 Atl. 392, that the county could not recover back the amount of the excess payment, under the rule, applied in prior specified cases in that jurisdiction, that where a municipal corporation has the right and power to enter into a given contract, it can legalize it after it has been performed under the authority of its unauthorized agents, and convert the money so earned into a legal debt.

LIABILITY FOR LETTING PUBLIC WORKS CONTRACT WITHOUT BOND TO PAY FOR MATERIAL AND LABOR ONLY ATTACHES ON INSOLVENCY OF CONTRACTOR

The Minnesota Supreme Court holds, Fargo Cornice & Ornament Co. v. School Dist. No. 88, 188 N. W. 733, that the liability imposed by Section 8246, Minn. Gen. St. 1913, on a municipality which lets a contract for doing public work without taking a bond to secure the payment of claims for material and labor furnished the contractor, does not attach unless the contractor be insolvent, and cannot be enforced without proving such insolvency. The court quotes Wilcox Lumber Co. v. School Dist. No. 268, 103 Minn. 43, to the following effect: "The fact that plaintiff presented its bill to the contractor for payment and that he did not pay it is far from conclusive that he could not pay it, or could not have been compelled to do so by appropriate legal proceedings."

CITY HELD NOT LIABLE FOR ITS NEGLIGENCE OR THAT OF ITS SERVANTS IN REGARD TO INSTRUMENTALITIES IN PUBLIC PARKS

The park commission of the city of Virginia, Minnesota, maintains a slide in a public park of the city. In using it, one was injured because of an alleged defect therein, and sued the park commission and the city for damages. The Minnesota Supreme Court, Emmons v. City of Virginia, 188 N. W. 561, stated the controlling question in the case to be: Is a city which equips its public parks with instrumentalities for diversion and exercise, for the free use of its inhabitants, liable in damages to one injured in their use because of negligent construction or maintenance? In some states this question has been answered in the affirmative, in others, in the negative. The court mentioned in its opinion as holding that liability exists, the courts of Colorado, Delaware, Oklahoma and Pennsylvania; and as holding nonliability of the city, Kansas, Kentucky, Massachusetts, Michigan, New Jersey, Rhode Island, Tennessee and Wisconsin. Whether these courts rendered their decisions on facts and statutes similar to those here involved the Minnesota court did not enquire.

The court takes the view of nonliability, on the ground that "cities, through park and school boards, have of late provided playgrounds equipped with various instrumentalities for exercise and amusement. Where this is done for the public good and gratuitously, the cities and their servants are to be regarded as agencies of the government, and are not acting in a proprietary character." There was no allegation that the commission or the city charged a fee for using the slide or derived income from equipment furnished for the public amusement. In this respect such a case differs from those where the city undertakes to furnish water or light to individuals for a price. And no allegation of the complaint brought the slide within the definition of a nuisance.

CARE REQUIRED IN USING CONCRETE MIXER IN STREET

The California courts hold, Jackson v. Leonardt & Peck, 207 Pac. 500, that the maintenance of a concrete mixer in a street under a regular permit from the city authorities, which stood close to the curb, about 100 feet from a street intersection, with the hopper raised, in which position it would be less of an obstruction than if lowered, was not negligence rendering the contractor liable for injuries to an automobile which was driven into it in broad daylight. A barricade around the mixer was not necessary, and could merely have added to the obstruction without giving any better notice of the presence of the mixer than did the latter itself. The contractor was, of course, under a duty to place the machine so that it would not unnecessarily obstruct travel, or be likely to produce injury to those who, using reasonable care, might travel upon the street.

ZONE SYSTEM OF ROAD IMPROVEMENT ASSESSMENTS APPROVED.

The Arkansas Supreme Court, Desha Road Improvement Dist. No. 2 v. Stroud, 241 S. W. 882, holds that the zone system of road improvement assessments is not an improper method if it is determined upon by the commissioners in the exercise of judgment, after considering all the elements affecting the benefits.

PROPERTY OWNER CAN BIND HIMSELF BY CONTRACT TO PAY CONTRACTOR FOR STREET IMPROVEMENT.

In an action by a construction company against an abutting owner on a special assessment certificate issued for the paving and improvement of of a street and on a contract signed by the owner, it appeared that the contract required the work to be constructed in accordance with the plans and specifications adopted by the city and set out in the contract between the city and the contractors. The question whether the paving was so constructed was submitted to the jury, which answered "Yes." The Texas Court of Civil Appeals holds, Cannon v. Healy Const. Co., 242 S.

W. 526, that the construction company was legally entitled to recover upon the promise contained in the owner's written contract. The owner could legally make a personal contract concerning the improvement in the street.

CITY CHARTER AND ORDINANCES FIXING MINIMUM WAGES FOR PUBLIC WORK HELD VALID

The Washington Supreme Court holds, Jahn v. City of Seattle, 207 Pac 667, that the charter provisions of Seattle and its ordinances providing that contractors for improvement work for the city shall pay employees thereon not less than the current wages paid by the city for such work, and not less than a specified amount, and shall give preference to citizens who are heads of families, are valid even if the wages be unreasonable, the validity of such statutes and ordinances not being dependent upon the exercise of the police power, which must be reasonable. Citing Malette v. Spokane, 77 Wash. 295, the court said: "The state and the various municipalities within it have the right to say that public work shall be done in any manner, at any price, and upon any terms which they see fit to lay down. It is in the power of the state and of its subsidiary municipalities to say that public work shall not be done, or that it may be done, and in the latter case it can prescribe the terms and conditions upon which it will allow it to be proceeded with. These are matters which the people have the right to determine for themselves, without interference by the court, after they have spoken their will, as here, by the adoption of a charter and the passage of ordinances by their legislative representatives. The courts no more will attempt to say what wages must be paid upon public work, what hours of employment shall prevail, or the class of people who shall perform that work, than they will attempt to interfere and prescribe the material to go into the work, the manner of construction, or other engineering details of a public improvement."

CONSTRUCTION OF ACT AUTHORIZING ISSUE OF WARRANTS TO PAY FOR CONSTRUCTION AND MAINTENANCE OF PUBLIC ROADS.

The Alabama Supreme Court holds, Court of County Comrs., De Kalb County v. McCartney, 92 So. 439, that Ala. Acts 1920, p. 10, §§ 1, 8, authorizing a court of county commissioners of any county to issue interest-bearing warrants for settlement of any debt or obligation incurred in construction or maintenance of public roads, gives such court no power to issue and sell such warrants, with interest coupons attached, payable in the future, to raise cash to make an appropriation for the purpose of constructing public roads.

CONTRACTS BY STREET RAILWAY COMPANIES TO REPAIR OR REPAVE STREETS

One of the customary requirements found in grants by municipalities to street railways to occupy the streets is the obligation by the company to repair or repave the streets occupied; though irrespective of any contract it is bound to keep in condition the portion of the highway used by it. The Pennsylvania Supreme Court holds, Borough of Collingdale v. Philadelphia Rapid Transit Co., 117 Atl. 909, that where, in consideration of the franchise, the company has agreed to make the necessary improvements, the terms of the contract must be complied with until it has, by some recognized legal method, been formally released from the agreed obligation, if the right to occupy the street is to be retained, and this liability extends to a merged or leasing company; and the duty may be enforced specifically, or the required work may be done by the municipality, and the cost thereof collected from the railway company. A statutory provision that no contract between a municipality and any public service company shall be valid unless approved by the public service commission, made effective upon the passage of the act, does not apply to contracts entered into before that time.

PROCEDURE WHERE NO BIDS FOR STREET IMPROVEMENT RECEIVED—COST AS FIXING NECESSITY FOR ADVERTISEMENT

The Kentucky Court of Appeals holds, City of Tompkinsville v. Miller, 241 S. W. 809, that where a statute empowers a city to construct a street and require the abutting owners to pay a proportion of the cost, the fact that the work was advertised and offered for contract with the lowest and best bidder, and no bids were received, does not entitle the city to have the work done through a committee or agent, and then impose the cost of it upon the abutting property; in such case it must abandon the project, or else have the improvement made and pay for it out of the general fund.

It is also held that where the necessity of advertising for bids is determined by the cost of a street improvement, it is the cost of the entire improvement, not the portion of the cost assessed against the lands in controversy which is to be considered, since the statutory provision fixing the limit cannot be evaded by splitting the work into sections.

MUNICIPALITY MAY DISPOSE OF PROPERTY OWNED BY IT NOT APPROPRIATED TO PUBLIC USE.

Property owned by a city for governmental purposes and appropriated for the public use is impressed with a trust and cannot be disposed of, except by valid legislative authority. As a general rule, however, a municipal corporation, unless restricted by its charter, or by statute, has the power not only to acquire property, real and personal, but, where not appropriated for the public use, may alienate the same just as other corporations or individuals might do. Where property is acquired or held for a special purpose, as soon as that purpose is served, and the corporation has no further use for the property, it may be converted to another use, or disposed of by the municipality.—City of Williamsburg v. Lyell, Virginia Supreme Court of Appeals, 112 S. E. 666.

WHAT A VOTE OF MAJORITY OF QUALIFIED ELECTORS OF A CITY MUST INCLUDE.

The Kansas Supreme Court holds, Clayton v. Hill City, 207 Pac. 770, that a provision of the statute authorizing cities among other things to construct a transmission line to obtain electricity from a plant outside its boundaries that no bonds shall be issued under it except upon "a vote of a majority of the qualified electors of such city" means that those voting in favor of the bonds must form a majority of all entitled to vote at the election, and not simply a majority of those voting thereat.

NEWS OF THE SOCIETIES

CALENDAR

Nov. 18—4-STATE SECTION, AMERICAN WATER WORKS ASSOCIATION. meeting in Baltimore, Md. Secretary, C. R. Wood, P. O. Box 363, Philadelphia, Pa.

Nov. 21—PROVIDENCE SECTION AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Joint meeting with Providence Engineering Society. Secretary, W. A. Kennedy, 301 W. Exchange Street, Providence, R. I.

Nov. 28 — ATLANTA SECTION, AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Secretary, E. A. Brooks, 702 Candler Bldg., Atlanta, Ga.

Dec. 7-13—NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING. New York City.

Dec. 14-15—KANSAS ENGINEERING SOCIETY. Annual meeting in Chamber of Commerce rooms, Topeka. Secretary, J. M. Averill, Topeka, Kansas.

Jan. 11-12—AMERICAN ENGINEERING COUNCIL. Annual meeting at new headquarters of F. A. E. S., 24 Jackson Place, Washington, D. C. Secretary, L. W. Wallace, 24 Jackson Place, Washington, D. C.

Jan. 11-12—FEDERATED AMERICAN ENGINEERING SOCIETIES. Annual meeting, Washington, D. C.

Jan. 15-17—NATIONAL CRUSHED STONE ASSOCIATION. Annual convention at Chicago. Secretary, A. P. Sandles.

Jan. 15-18 — AMERICAN ROAD BUILDERS ASSOCIATION. Annual convention, Chicago.

Jan. 17-18—AMERICAN SOCIETY OF CIVIL ENGINEERS. Annual meeting, 29 West 39th Street, New York City. Secretary, John H. Dunlap.

Jan. 22-26—AMERICAN CONCRETE INSTITUTE. Annual convention, Cincinnati.

Jan. 23-26—IOWA ENGINEERING SOCIETY. Annual Meeting in Des Moines. Secretary, Lloyd A. Canfield, 406 Flynn Building, Des Moines.

Jan. 30-Feb. 3—ASSOCIATED GENERAL CONTRACTORS OF AMERICA. Annual meeting, Los Angeles, Calif.

May 7-9—AMERICAN ASSOCIATION OF ENGINEERS. Ninth annual convention, Norfolk, Va. Secretary, C. E. Drayer, Chicago.

May 21-25 — AMERICAN WATER WORKS ASSOCIATION. Annual convention. Statler Hotel, Detroit, Mich. Secretary, John M. Diven, 152 West 71st Street, New York City.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS

The eighth annual meeting of the American Association of State Highway Officials will be held at the Baltimore Hotel, Kansas City, Mo., on December 4th to 7th, inclusive. The most important feature of this meeting will be the group meetings, where sub-committee discussions will be held covering plans and surveys, design, specifications, traffic control and safety, and bridges and structures. These discussions are to take place during the afternoon of Dec. 4th and no general sessions will be held at this time. There will also be meetings of the Committees on Administration, Construction, Motor Truck Regulation, Maintenance, Standards, Tests and Investigations, and Publications.

On Dec. 4th a paper will be read by A. R. Hirst, state highway engineer of Wisconsin, entitled, "Troublesome Problems Encountered in the Administration of a State Highway Department." On Dec. 5th A. B. Fletcher, state highway engineer of California, will deliver an address on "Financing Construction and Maintenance on a State Highway System," and Clifford Older will speak on "The Service Tests of the Bates Road—a Step Toward the Rational Design of Roadway Surfaces." T. E. Stanton, assistant state highway engineer for California, will give the conclusions derived from studies of the effect of traffic on the Pittsburgh, California test road as they affect the design of pavement sections. Bridge design will be considered on the evening of Dec. 5th, the principal paper being by L. N. Edwards, bridge engineer of the Maine State Highway Commission. Additional papers will be read by C. N. Connor, assistant engineer of the North Carolina Commission, and C. B. McCullough, bridge engineer for the Oregon Commission.

On Dec. 6th Thomas H. MacDonald, Chief of the U. S. Bureau of Public Roads, will discuss "The Functioning of the Federal Aid Policy," and "The Handling of Federal Aid from the State Point of View" will be discussed by Rollen J. Windrow, consulting engineer to the Missouri Highway Commissioner. In the afternoon John H. Mullen, deputy commissioner of highways for Minnesota, will present a paper entitled, "A Construction Division, Its Financing, Organization and Operation"; and "The Field Control of State Highway Maintenance Work" will be discussed by G. C. Dillman, deputy commissioner of the Michigan State Highway Department.

The election of officers and receiving of committee reports are on the program for the morning session of Dec. 7th.

GOOD ROADS CONGRESS AND SHOW

The arrangements for the Thirteenth American Good Roads Congress and Fourteenth National Good Roads Show, to be held in Chicago on January 15th to 19th, are in the hands of an organization which was formed after this year's Congress and the revision of the Constitution and By-Laws. The exhibitors at the last show formed an organization known as the Highway Industries Exhibitors Association, while the Executive Committee of the Road Builders Association appointed a Special Convention and Show Committee to have supervision of all arrangements for the Congress. This committee consisted of C. M. Upham as chairman and James H. MacDonald, both representing the A. R. B. A., and S. F. Beatty, who is president of the Exhibitors Association. This General Committee has created a number of sub-committees on program, reception and hotel, entertainment, registration, exhibits, banquet, local press, transportation and general publicity. Each of these sub-committees will be composed of active members of the Road Builders organization who have had experience with past expositions and conventions.

At first the Exhibitors Association felt that, without co-operation with the A. R. B. A., it would be better to undertake the Road Show independently of the other Association, but the latter association asked for one more year in which to demonstrate its ability to handle the show as it should be handled, and this was agreed to with the condition that a Director of Exhibits should be appointed who would be an experienced man and not connected with either association; that the sessions of the convention should not be held in the Coliseum, since that necessitated too frequent shutting down of the machinery during the meetings of the A. R. B. A.; and that an audit of the Road Builders Association should be prepared so that the Exhibitors Association could learn how the surplus was being used.

In carrying out this agreement, the Exhibits Committee has employed C. W. Kelly of Chicago as Director of Exhibits and C. S. Lee of New York as Director of Publicity. Mr. Lee handled the publicity work for the 1921 and 1922 conventions and shows, while Mr. Kelly has staged some of the biggest expositions in the country.

According to Chairman Upham, the chief difficulty will be in providing space for all the exhibits offered, although arrangements will be made for all the additional space that it is possible to obtain.

Mr. Upham states that the program for the Congress will be entirely different from previous ones, in that, instead of avoiding controversal subjects as in the past, the program will consist of such subjects of vital interest to the whole road-building industry. It is expected that this will heighten the interest in the sessions and provoke informative oral discussions.

The general offices of the American Road Builders Association have been moved from 11 Waverly Place, New York, to 37 West 39th Street, in that city. The headquarters of the Highway Industries Exhibitors Association is at 400 North Michigan Boulevard, Chicago.

A. S. M. E. SECTIONAL MEETINGS

During November there will be meetings of local sections of the American Society of Mechanical Engineers, at least two of which will discuss subjects of interest to public

works engineers. One is a meeting of the Providence, R. I., section jointly with the Providence Engineering Society, at which an address on "The Engineer and the Home" will be given by Mrs. Frank B. Gilbreth, of Montclair, N. J.

The other will be the meeting of the Atlanta Section at the Town Hall in Atlanta, where R. H. Cunningham, southern representative of the Ingersoll-Rand Co., will speak on "Diesel and Semi-Diesel Engines vs. Small Steam Engines in Power Stations up to 500 k. w." which subject will be discussed by R. B. Hall of the Ames Iron Works and W. H. Davidson of the Fulton Iron Works.

NEW ENGLAND WATER WORKS

The Nominating Committee has submitted the following list of nominees for officers to serve during 1923: For President, Percy R. Sanders, Superintendent of Water Works, Concord, N. H.

For Vice-Presidents, Geo. A. Carpenter, City Engineer, Pawtucket, R. I.; Reeves J. Newsom, Commissioner of Water Supply, Lynn, Mass; David A. Heffernan, Superintendent of Water Works, Milton, Mass.; Frank E. Winsor, Chief Engineer Board of Water Supply, Providence, R. I.; Theodore L. Bristol, President and Manager, Ansonia Water Co., Ansonia, Conn., and Vernon F. West, Treasurer and Manager of Water Companies, Portland, Me.

For Secretary, Frank J. Gifford, Superintendent, Dedham Water Company, Dedham, Mass.

For Treasurer, Frederic I. Winslow, Division Engineer, Metropolitan Water Works, Framingham, Mass.

For Editor, Henry A. Symonds, Consulting Engineer, Boston, Mass.

For Advertising Agent, Fred O. Stevens, Superintendent of Water Works, Weymouth, Mass.

For additional members of the Executive Committee, Frank A. Marston, Consulting Engineer, Boston, Mass.; Stephen H. Taylor, Superintendent of Water Works, New Bedford, Mass., and Geo. A. Sampson, Consulting Engineer, Boston, Mass.

For Finance Committee, A. R. Hathaway, Water Registrar, Springfield, Mass.; E. D. Eldridge, Superintendent Onset Water Co., Onset, Mass., and Arthur N. Birnie, Superintendent Biddeford & Saco Water Co., Biddeford, Me.

ASSOCIATED GENERAL CONTRACTORS

The Executive Board has announced the nominations for next year's officials as follows: For president, W. E. Wood, president of the W. E. Wood Co. of Detroit; for vice-president-at-large, A. P. Greensfelder, secretary of the Fruin-Colnon Contracting Co. of St. Louis; for vice-president, Zone 4, J. H. Ellison, vice-president of Winston-Dear Co. of Minneapolis; for directors, James E. Cashman, Burlington, Vt., Frederick Ward, Brooklyn, N. Y., W. F. Creighton, Nashville, Tenn, D. B. Fegles, Minneapolis, George Watson, Dallas, Tex., Matt McDougall, Portland, Ore., J. C. Edwards, Los Angeles, Calif., and H. W. Baum, Salt Lake City.

AMERICAN PUBLIC HEALTH ASSOCIATION, SANITARY SECTION

A meeting of the Sanitary Section of the A. P. H. A. was held in Cleveland, October 16 to 19. A paper on the situation at Lima, O., where a direct oxidation plant recommended by George A. Johnson, and one along standard lines proposed by George W. Fuller are under consideration, was read by the latter engineer. Following a discussion, a committee was appointed by the section to investigate the electrolytic process.

Langdon Pearse read two papers, one a review of the conditions in the larger cities on the Great Lakes as to water supply, sewage disposal and typhoid fever; the other a report on sewage sludge, both of which are abstracted in this issue.

The report of the Committee on Definition of Sewage Treatment Terms was referred back for further consideration. A special committee was appointed to consider the standard specifications for plumbing that have been sent out by the Building Code Committee of the Department of Commerce, Paul Hansen being made chairman.

The following were elected for the coming year: Kenneth Allen, chairman; H. A. Whitaker, vice-chairmen; E. D. Rich, secretary.

BOSTON AFFILIATED TECHNICAL SOCIETIES

The Affiliation Meeting, referred to in our October issue, is set for November 23, with three papers on "Commercial Aviation" as the chief feature. "Commercial Aviation in Europe and the Development of Heavier-Than-Air Machines" will be the title of a paper by E. P. Warner, associate professor of Aeronautical Engineering, of the Massachusetts Institute of Technology. Edward Schildhauer, of the American Investigation Corporation, will discuss "The Development of Lighter-Than-Air Ships." "Boston Air Port" is the title of a paper by James T. Williams, editor-in-chief of the Boston Evening Transcript. These papers will be illustrated by slides and possibly by motion pictures. Prof. Dugald C. Jackson will speak briefly on "The Aims and Accomplishments of the Affiliation." The meeting, which will be held in Tremont Temple at 8.00 P. M., will be preceded by a Smoker at 6.15 P. M., in the Affiliation Rooms, at which the Boston Society of Civil Engineers will act as host.

On December 6, the Boston Society of Civil Engineers, Sanitary Section, will be given an informal talk on "Water Supply and Sewerage in Australia," by A. C. Getteridge, Fellow of the International Health Board.

The Boston Chapter of the American Association of Engineers will hold its regular monthly meeting on December 8.

The Designers Section of the Boston Society of Civil Engineers will meet December 13, when C. B. Breed, professor of Railway and Highway Engineering at the Massachusetts Institute of Technology, will read a paper on "Present Day Developments in Highway Design."

The Boston Society of Civil Engineers at its meeting on December 20, will discuss "The Manufacture and Distribution of Gas." A model water-gas plant in operation will be exhibited.

FOUR-STATE SECTION, A. W. W. A.

There will be a meeting of the "Four-State Section" of the American Water Works Association in Baltimore, Maryland, on Saturday, November 18, 1922.

Members will assemble at the Holliday Street entrance of the City Hall, Baltimore, at 12:30 p. m., whence they will be taken, through the courtesy of the Baltimore City Water Department, by automobile to the Montebello Filtration Plant, where luncheon will be served at 1:00 p. m. Following luncheon a short address will be made by William A. Megraw, water engineer, Baltimore City, after which papers will be read on the subjects given below:

"A Discussion of the Finances and Conduct of Business of a Municipally-Owned Water Works as Segregated from Other Municipal Operations," by V. Bernard Siems.

"Recent Developments in Water Purification at the Montebello Filtration Plant," by James W. Armstrong.

After the reading these papers will be discussed by the members present.

All those so desiring will then be taken to various points of interest about the Baltimore water works. After these trips non-resident members will be taken to the various railroad stations in time to board trains leaving Baltimore around 5:00 p. m.

NATIONAL HIGHWAY TRAFFIC ASSOCIATION

A joint meeting of the North Central Division of the National Highway Traffic Association and the Michigan State Good Roads Association will be held Tuesday, November 21, at Grand Rapids, Mich., at the Hotel Pantlind. In the afternoon George H. Pride, treasurer of the former association and president of the Heavy Haulage Company, of New York, will address the meeting on "Regulations Covering Speeds, Weights and Dimensions of Motor Trucks,

Tractors and Trailers"; "Regulation of Overloading of Motor Trucks" will be discussed by David C. Fenner, manager of Public Works Department, International Motor Co.; and "Lights for Highway Vehicles, Motor-Driven and Horse-Drawn," will be the subject of a paper by David C. Beecroft, vice-president, North Atlantic Division, National Highway Traffic Association.

In the evening Roy D. Chapin, vice-president of the National Automobile Chamber of Commerce and president of the Hudson Motor Car Company, will speak on "Equitable Distribution of Cost of Construction, Interest on Bonds, Replacements and Maintenance of State Highways," and Professor Arthur H. Blanchard, president of the National Highway Traffic Association, on "The Economic Value of Highway Transport Franchises."

NATIONAL MUNICIPAL LEAGUE

The twenty-eighth annual meeting will be held in Philadelphia on November 22 to 24 at the City Club. On the first day action will be taken on the nominations of the nominating committee, including Colonel Henry M. Waite for president, Carl H. Pforzheimer for treasurer, and ten for members of council.

On Wednesday Harlan Updegraff will speak on "The System of State Education in Pennsylvania"; Kenneth L. M. Pray on "The Administration of Charities and Corrections," and H. C. Connell on "Pennsylvania's Road System."

On Thursday "The Wisconsin Idea of Personnel Administration" will be explained by Allen M. Ruggles, service examiner of the Civil Service Commission of Wisconsin; "Civil Service from the Viewpoint of the Administration," by Morris L. Cooke, formerly director of public works of Philadelphia; "Progress in Selective Tests in Public Employment," by Dr. L. B. O'Rourke, of the U. S. Civil Service Commission, and the report of the Committee on New Standards of Municipal Employment will be submitted by the secretary, Dr. W. E. Mosher.

On Thursday afternoon the subject of the discussion will be "The Problem of Criminal Justice." In the evening it will be "Our National Budget." On Friday morning "Reporting Government" will be the topic, and in the afternoon "What's the Matter with Congress?"

PERSONALS

Hammond, A. J., Chicago, in October became associated with James O. Heyworth, of that city, in his engineering and general contracting business.

Worrell, M. L., has been appointed engineer and manager of the water works of Vicksburg, Miss.

Atlee, J. Walter, is located at Ledger, N. C., as engineer with the North Carolina State Roads Commission.

Del Plaine, C. W., is the new field agent of the League of Minnesota Municipalities.

Dimock, Arthur H., formerly city engineer of Seattle, has opened an office in that city and will specialize in hydraulics, waterworks and sanitary engineering.

Uhler, Col. William D., died October 27th after a week's illness. He had been chief engineer of the Pennsylvania State Highway Department since 1915, and had been engaged in highway work since 1904. He was a past president of the American Association of State Highway Officials. He was fifty years of age.

Griffin, J. B., on November 1, became city engineer of Venice, Calif.

Reppert, Charles M., chief engineer of the Bureau of Engineering of Pittsburgh, Pa., has resigned and will enter private practice. He has occupied this position about a year, having formerly been in the firm of Morris Knowles, Inc.

Allen, Robert A., has been appointed state engineer of Nevada. He was for three and one-half years deputy state engineer.

Fitz Randolph, Dr. R. B., chief of the hygienic laboratory of the New Jersey State Department of Health, died October 22. He was fifty years of age.

Coggeshall, R. C. P., superintendent of water works of New Bedford, Mass., died Oct. 20. He had been superintendent of those works for more than 25 years. He was an honorary member and past president of the New England Water Works Association and was its secretary for a number of years.

Flinn, Alfred D., has been elected to fill the new position of Director of the Engineering Foundation, of which he has been secretary for nearly five years. He will continue as secretary of the United Engineering Society but will retire as chairman of the Engineering Division of the National Research Council.

Birdsall, Lewis I., superintendent of filtration of the Minneapolis water works, has resigned to accept a position as water expert with the General Chemical Co. at Chicago.

Mellen, Arthur F., assistant superintendent of filtration of the Minneapolis water works has been appointed superintendent, succeeding Mr. Birdsall.

Neighbour, H. M., recently resident engineer for El Paso County, Tex., has become field engineer on concrete bridges for Maniopa County (Ariz.) Highway Commission.

Wagner, Gerald J., has been engaged by Grand Rapids, Mich., as consulting engineer on public utility matters. He was formerly director of public service.

Gardiner, J. C., has resigned as city engineer of Niagara Falls, Ontario.

Scott, T. S., of Kingston, Ontario, has been appointed city engineer in Niagara Falls, Ontario.

Friel, Francis S., formerly assistant engineer of the Pennsylvania Department of Health, has resigned and become associated with Albright & Mebus, of Philadelphia.

Keeney, Giles B., of Meriden, Connecticut, succeeds Clayton E. Swain as superintendent of public works at Rockville, Connecticut.

Fisher, Chas. F., formerly engineer of the City Planning Commission of Akron, Ohio, has resigned and is employed by Robt. Whitten, Cleveland, Ohio, being at present located at Providence directing studies for the zoning of that city.

Cock, Calvin E., has been appointed county engineer of Neches Co., Texas.

Perie, James, has been appointed city engineer of Ballinger, Tex.

PAMPHLETS

"Mosquitoes of the United States," by Harrison G. Dyar, Custodian of Lepidoptera of the U. S. Museum. This is printed as Bulletin No. 2447 of the Proceedings of the Museum. Lists several hundred mosquitoes under their generic, sub-generic, specific and sub-specific names. Gives complete anatomical and structural description with life history, breeding characteristics, habits, etc. A valuable reference work to one engaged in mosquito control or research work.

"The Re-Heating of Compressed Air," by C. R. Richards and J. N. Vedder. A bulletin of the Engineering Experiment Station of the University of Illinois giving conclusions from an investigation undertaken to determine the ideal thermodynamic efficiencies resulting from the heat expended in re-heating compressed air, the efficiency of external and internal combustion re-heaters, and the performance of an engine operated with air used expansively with steam alone, and with a mixture of air and steam. Published by the Experiment Station at Urbana, Illinois.

"Tests of Drainage Pumping Plants in the Southern States," by W. B. Gregory, irrigation engineer. Bulletin No. 1067 of the U. S. Department of Agriculture, 54 pages in length, describing the types of pumps used in the Gulf coast country, the sources of power, methods and typical results of testing drainage pumping plants (this occupies 70 per cent. of the space in the bulletin), and figures as to cost of operation.

New Appliances

Describing New Machinery, Apparatus, Materials and Methods and Recent Interesting Installations

REDFLEX WARNING SIGNALS.

Signals for highways known as the "Redflex" (also "Greenflex" and "Yelloflex") are being placed on the market by Thompson Brothers Company for use at danger points on highways such as turns, dead ends, railroad crossings, bridges or culverts, and also as a "silent policeman" or street intersection signal.

The "Redflex" consists of specially constructed laminated lens made of pot colored crystal glass of superior brilliancy with a nickeled brass reflector, the lens protected with ¾" expanded metal that has been hot galvanized after being formed. The lens is hermetically sealed in the reflector and these in turn are sealed in a cast aluminum case, while the screen is attached in front of the lens in the same case by means of copper fasteners.

The standard size of lens is 12" square. For most highway work it is attached to a post of 2" galvanized pipe which raises it about 30" above the surface. Above the square lens is placed a danger signal of heavy cast aluminum copper alloy containing raised letters 4¾" high.

The brass reflector has its surface broken into 144 surfaces, each reflecting light at a somewhat different angle.

This signal contains no light in itself and no mechanism, but relies for its efficiency at night upon the fact that if any automobile approaches it with headlights burning the reflector will be lighted by these and the light so received will be reflected back to the driver and appear like a large, brilliant ball of red fire.

The sign is installed by setting the post, which is a 5-foot length of pipe, in a concrete base which insures rigidity and permanence. The lens is then adjusted by an adjusting device so as to reflect the light in the proper way, which will cause it to be visible at a distance of 1,000 ft. or more. The posts are ordinary two-inch galvanized iron pipe and may be purchased at a local plumbing supply store or will be sent by the manufacturer. It is claimed that the light reflected from this lens will penetrate fog, dust, or rain, more effectively than a lighted signal.

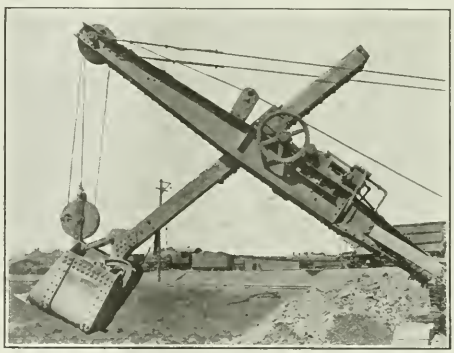
Where used for street intersections, the signal consists of a flat octagonal box of cast steel that rises 6¾" above the street level and contains a "Redflex" lens in each of its eight sides, the lenses being so protected that they canot be hit by traffic. In an emergency a motor vehicle may pass over the signal without serious damage. The base of the signal is 20" in diameter and is set down into the paving material, eight lugs which are cast integral with the base preventing movement of the signal in the concrete or other paving material.

NEW COMBINATION CRANE AND SHOVEL

A combined utility machine for the contractor, supply yard, railroad, or industrial plant, has recently been introduced by the Orton & Steinbrenner Company. This machine is a combination of locomotive crane and steam shovel with continuous tread. Two sizes are manufactured with capacities of ¾-yard and 1-yard, respectively. The change from crane to shovel is made by merely removing the crane boom and substituting the shovel boom and dipper. A separate boom with a skimmer scoop can be connected to the crane independent of the main crane boom, and the hoist line simply reeved over the scoop.

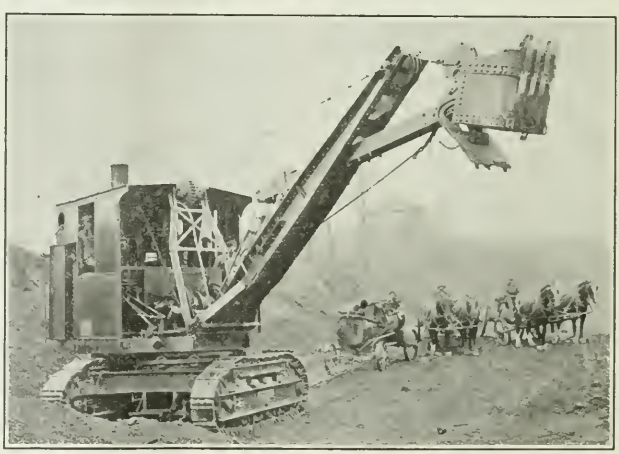
The radius of the boom, instead of being fixed at a certain degree, may be varied to suit the conditions of the job, which feature enables it to dig several feet below the normal operating level and also increases the lift. The rotating base turns on a live ring of rollers on a large-diameter rail circle, thus distributing the load evenly and requiring very little power to swing.

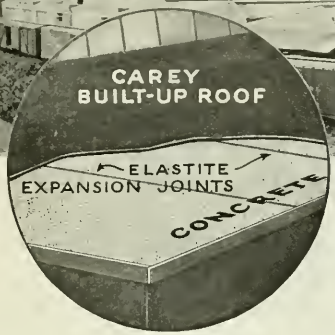
Motive power is supplied by only two engines. The hoisting, swinging and traveling portions are performed



ORTON & STEINBRENNER COMBINED CRANE AND STEAM SHOVEL.

At left is view of boom, showing separate reversing engine to give crowding motion to dipper.





How would you make a concrete roof safe from expansion fractures?

IN the case of this roof of the Hall Mfg. Co., Cedar Rapids, Iowa, Elastite Expansion Joint was used. The concrete deck is laid in slabs with Elastite at every joint.

In midsummer the temperature on this roof is as high as 110 degrees. In winter it drops to 10 degrees below. But the Elastite never melts in the heat nor loses its elasticity in low temperature. The melting point of Elastite is 250 degrees Fahrenheit. It is still elastic at 32 degrees Fahrenheit.

Elastite makes concrete construction for roofs, streets, bridges and other structures safe from injuries by expansion and contraction.

Elastite shows its superiority over all other joint materials both in service and ease of installation. It is as easy to handle as a board, does not buckle in hot weather and does not break and chip in cold weather.

Immediate shipments anywhere in any quantity from large stocks at seventeen convenient distributing points. Write for sample and further facts.

THE PHILIP CAREY COMPANY
10 Wayne Avenue, Lockland, Cincinnati, Ohio

Elastite is a body of specially tempered asphalt sandwiched between two layers of asphalt saturated felt and comes to the job cut to any dimension and shape, or cut to crown, ready to install in a single operation.

The asphalt in Elastite is refined by special Carey processes producing a material retaining its ductility and plasticity within a temperature range of 32 degrees and 250 degrees Fahrenheit under laboratory tests. This is the reason for the unique service characteristics of Elastite.

10-22

Carey Elastite

TRADE MARK REG. U.S. Pat. Office

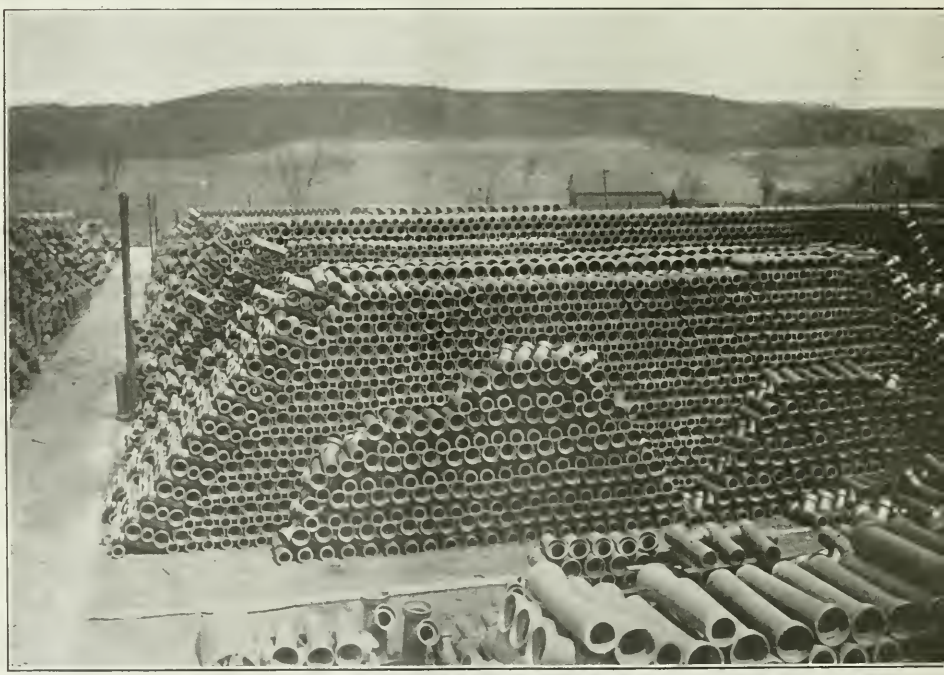
PROVED AND ACCEPTED EXPANSION JOINT

Made like a sandwich
Installed like a board

TESTED BY FIRE

VITRIFIED CLAY PIPE

The Pipe Everlasting



Large stocks ready for shipment at a moment's notice

Thousands upon Thousands
of feet of Vitrified Clay Sewer Pipe
shipped by our various members every day

The importance of quick service and shipping facilities is solved by the location of the companies listed below. Each and every one of the members of this association pursue the most progressive known methods. Shipments made right to the job in any section of the country, promptly and efficiently. SERVICE FIRST—LAST—AND ALWAYS. And **Remember**—The association's facilities are at your service without charge.

Our engineers are ready at all times to give you complete information regarding the manufacture and use of Vitrified Clay products for every use.

We have ready for distribution a number of publications which will be of interest to you, including a handbook on house sewers and house drains. Write for copies and tell us your problems.

For Full Particulars write

Eastern Clay Products Association

Henry T. Shelley, Secy.-Mgr. :-: **Phone Spruce 5029**

906 Colonial Trust Building, Philadelphia, Pa.

Members Eastern Clay Products Association

The Buckeye Fire Clay Co., Uhrichsville, Ohio

Cambria Clay Products Co., Blackfork, Ohio

Clearfield Sewer Pipe Co., Clearfield, Penna.

Crouse Clay Products Co., Akron, Ohio

The Dennison Sewer Pipe Co., Dennison, Ohio

East Ohio Sewer Pipe Co., Irondale, Ohio

Evans Pipe Co., Uhrichsville, Ohio

Junction City Sewer Pipe Co., Junction City, Ohio

Logan Clay Products Co., Logan, Ohio

Patton Clay Mfg. Co., Patton, Penna.

Pennsylvania Clay Products Co., West Winfield, Penna.

Portland Stone Ware Co., 49 Federal Street, Boston, Mass.

Robinson & Sons Sewer Pipe Co., Uhrichsville, Ohio

Robinson Clay Product Co., Akron, Ohio

Ross Clay Products Co., Uhrichsville, Ohio

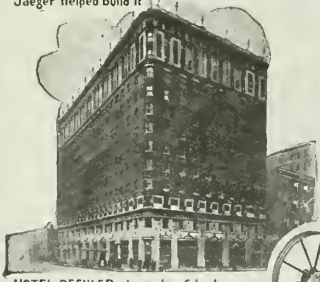
St. Mary's Sewer Pipe Co., St. Mary's, Penna.

Wolf-Lanning Clay Co., Dennison, Ohio

Columbus-99% for Jaeger

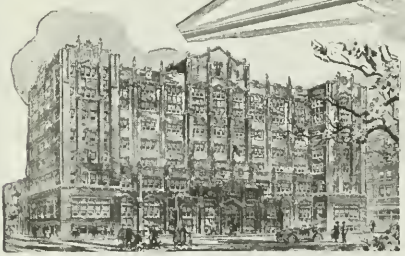
JAMES THEATRE - New Million Dollar Motion Picture House 3000 Seats Jaeger Helped Build it

ELKS HOME - Half a Million Dollar Structure - A Jaeger Job



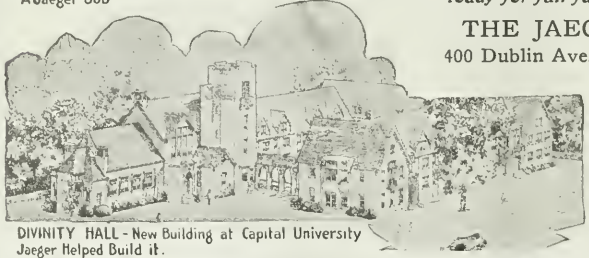
HOTEL DESHLER - Largest in Columbus 400 Rooms - A Jaeger Job

MOREHOUSE-MARTENS - New $400,000 STORE - Jaeger Poured.



Y. M. C. A. - New Million Dollar Structure - Jaeger Poured

LAZARUS STORE - Columbus' Largest Store - 150,000 sq ft A Jaeger Job



DIVINITY HALL - New Building at Capital University Jaeger Helped Build it.

Ninety-nine out of every hundred concrete mixers in Columbus, Ohio, are Jaegers

COLUMBUS is, indeed, a city "built by Jaegers." Practically every good-sized building erected here during the past 10 years has seen a Jaeger on the job.

True, this is the home-town of Jaeger Mixers. Yet something more than loyalty to home-town industry prompts Columbus contractors to buy Jaegers—*for they keep on buying them.* There are over 350 in use in Columbus today.

These men like the speed of the Jaeger tilting-drum feature. They like the simplicity, the perfect mixing quality, the low upkeep of this "Mix a Minute" outfit.

But you don't need to come to Columbus to find Jaeger enthusiasts. Ask almost any contractor in your town about the Jaeger. More than likely he will be one of the 18,000 satisfied Jaeger users. There's a Jaeger Mixer especially adapted to every type of public works concrete job. *Use the coupon today for full facts on this line of 18 mixers!*

THE JAEGER MACHINE COMPANY

400 Dublin Ave. Columbus, Ohio

The Jaeger Machine Co.
400 Dublin Avenue
Columbus, Ohio.

Gentlemen:—

Please send me full information on the Jaeger line of mixers.

Name .....

Address .....

.....

LOUISIANA
Warren-Bitulithic Pavement on Alexandria-Camp Beauregard Highway, paved in 1918.

Speaking of this road
and of

WARRENITE-BITULITHIC PAVEMENT

A member of the Louisiana Highway Commission says:

> "It was not necessary to build detour roads—saved annoyance and worry. This road has given excellent service, requiring little maintenance and has proved satisfactory to Parish, State and Federal Government officials."

And the same story comes from all parts of the country where this pavement is in use.

WARREN BROTHERS COMPANY

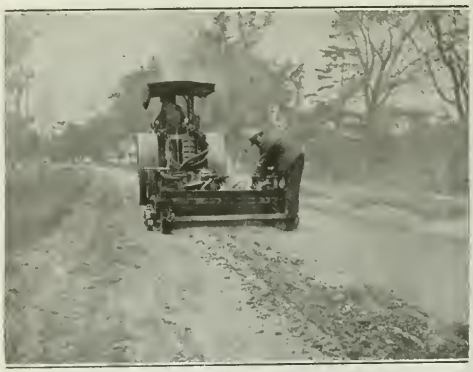
EXECUTIVE OFFICES:
BOSTON, MASS.

WARRENITE-BITULITHIC PAVEMENT — THE BEST BY EVERY TEST

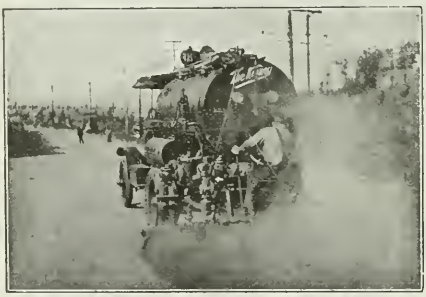
NEW YORK, N. Y.
LOS ANGELES, CAL.
RICHMOND, VA.
TORONTO, ONT.
WINNIPEG, MAN.
NEW ORLEANS, LA.

District Offices:

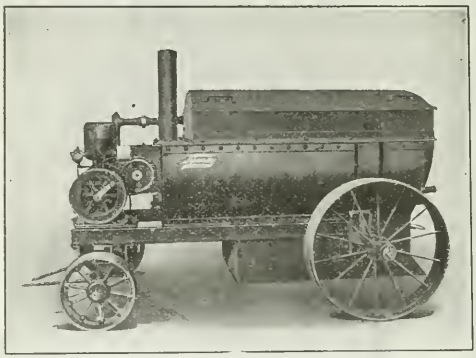
CHICAGO, ILL.
PORTLAND, ORE.
MEMPHIS, TENN.
MINNEAPOLIS, MINN.
VANCOUVER, B. C.
HARRISBURG, PA.
SALT LAKE CITY, UTAH
OAKLAND, CAL.
PHOENIX, ARIZ.
ST. LOUIS, MO.
UTICA, N. Y.
WASHINGTON, D. C.
DALLAS, TEX.



ROAD PLANER



PATENT COMBINATION AUTO HEATER AND SPRAYER



HANDY HEATER AND SPRAYER

TRADE MARK Kinney REG. U.S. PAT. OFF.

ROAD EQUIPMENT

Road Planer

This machine removes the bunches or ridgy elevations from the road surface without destroying the general contour of the road. The facilities for adjustment of the scarifiers and planers in any desired angularity or depth of cut, will fully meet the different conditions arising from changing temperatures or varying viscosities of the material used in the construction of the road. While designed especially for use on bituminous surfaces, the planer may also be used to good advantage on macadamized or dirt roads.

Patent Combination Auto Heater and Sprayer

Heats and applies under pressure all varieties of Bituminous materials; hot or cold. Heat and volume under instant control.

The tank and entire equipment can be removed and truck used for other purposes if desired.

Handy Heater and Sprayer

Especially adapted for Road Maintenance, Construction and General Repair Work.

Contents thoroughly agitated while heating. No burning or coking of material. Pump, Piping, Hose, Nozzles, Automatically Heated. No steam required.

Kinney Manufacturing Company

BOSTON, MASS.

New York *Philadelphia* *Chicago* *Houston* *Kansas City* *San Francisco*
Philippine Islands *Porto Rico* *Cuba* *Hawaiian Islands*

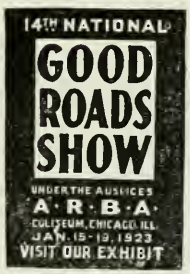
Stanolind

Paving Asphalt

The Ideal Country Road

VERY few pavements have the hard wearing traffic that falls to the lot of the average country road. Automobiles and trucks, tractors and wagons, loaded and unloaded, all conspire to effect its destruction.

To stand up under these trying conditions the road must be constructed to meet them. A substantial subgrade—a firm base and a shock-absorbing wearing course are the three factors essential to any road where traffic impact is heavy.



BOOTHS 9 AND 10, SECOND FLOOR, BALLROOM. DON'T FAIL TO SEE OUR INSTRUCTIVE EXHIBIT ON ROAD MAKING

Stanolind Paving Asphalt

provides an ideal material for the construction of such roads. It is laid at a low initial first cost and requires a minimum of maintenance. This latter feature is important, because money allowed by the tax payers usually does not provide for a large upkeep expense.

Hundreds of miles of country roads constructed by the Stanolind method years ago, are still in the best of condition although very little has been spent on them for repairs. We will gladly cite instances and supply details on request.

STANDARD OIL COMPANY

(INDIANA)

931 S. Michigan Ave. Chicago, Illinois

7-Ton Crawling Tread—40 ft. boom—¾ yd. bucket.

The Answer to Low Cost Material Handling. The solving of loading and unloading problems becomes simple when

O. S.

Dependable Cranes are installed

The Low Cost of Maintenance and Repair have well earned the title of Dependable.

Orton & Steinbrenner Co.
OFFICES:
608 SO. DEARBORN STREET
CHICAGO, ILLINOIS
Shops: Huntington, Indiana

ASPHALT PAVING PLANTS

PORTABLE
SEMI-PORTABLE
STATIONARY

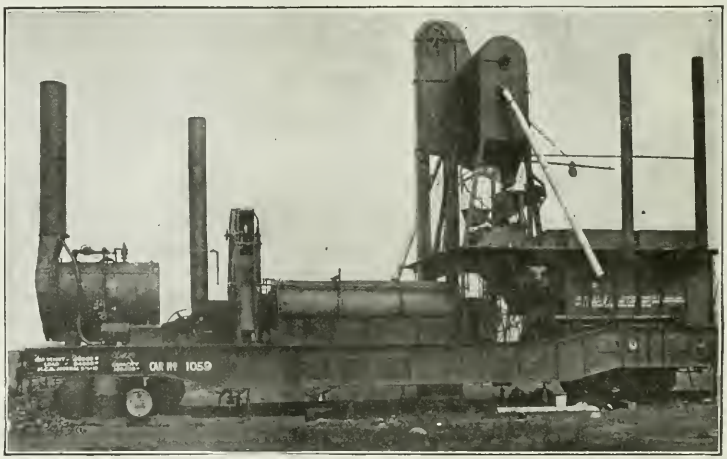
Sand & Stone Dryers

Portable Kettles

Asphalt Street Tools

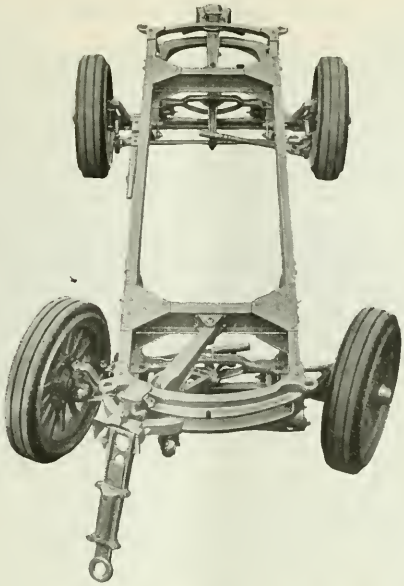
Brick Testing Rattlers

Gravel Pumps etc.



HETHERINGTON & BERNER

INDIANAPOLIS, IND.



DETROIT TRAILERS

Will reduce your transportation costs

Trailers must often by backed through narrow, curving alleys or up to crowded shipping platforms, freight sheds and boat terminals. DETROIT construction makes this easy.

When backing, the end next the truck is locked, automatically disconnecting the extension draw bar from the steering mechanism. This feature obviates the bent and broken draw bars and trailer connections incident to the backing of trailers of ordinary construction, as the driver is free to swing his truck from side to side of the entire limit of the trailer's turning radius. And by means of this "swivel draw head" a DETROIT Trailer can be backed into positions impossible to reach with the truck alone.

Other features include the easily operated and fool-proof locking device; knuckle type axles insuring four point suspension even when both ends are being steered, and the double acting draw bar springs, which by absorbing starting and stopping shocks, add considerably to the life of bo'h truck and trailer.

We believe the DETROIT is the best trailer made. Make us prove it to you.

Made in one of the largest Trailer Plants in the world

DETROIT TRAILER COMPANY 954 E. Milwaukee Ave. Detroit - Michigan

Shonnard Place, Yonkers, N. Y.

This road was built in 1920 using Standard Macadam Asphalt Binder "B" applied by Socony Asphalt Sprayer

STANDARD
ASPHALT
BINDER "B"
For Penetration Work

SO
SOCONY
ASPHALTS AND ROAD OILS

Standard Asphalt Products

Standard Asphalt Binder A *for surface treatment.*

Standard Asphalt Binder B *for penetration work.*

Standard Asphalt Binder C *for mixing method.*

Standard Refined Mexican Asphalt *for sheet asphalt paving.*

Standard Asphalt Joint Fillers *for brick and block pavements.*

Standard Paving Flux, Standard Bridge Asphalt and Preserving Oils.

Specifications and all other particulars furnished on request

STANDARD OIL CO. OF NEW YORK
26 Broadway

Breaking the Snow Blockade

The "Caterpillar's" field of usefulness is by no means limited to snow removal. There is a "Caterpillar"* of size and capacity for every power need. For grading and maintaining streets and roads, for work on farm or ranch, in the mining, oil and lumber industries—wherever tractive power and endurance are at a premium, the "Caterpillar"* has no real competitor.*

CATERPILLAR
Reg.U.S. Pat.Off.
HOLT
PEORIA, ILL.
STOCKTON, CALIF.

Leaving sixteen states in its wake, the big blizzard of last January struck New York City and New England with staggering force. New York was ready! So were many adjoining "Caterpillar"*-equipped cities and towns. Repeating the performance of the previous winter, New York's fleet of 50 "Caterpillars"* fitted with big snowplows, cut great furrows through the snow-blanketed streets and kept traffic moving. Three "Caterpillars"* put into action on the hilly streets of Yonkers quickly cleared its business and residential districts. Rye, Mamaroneck, and Harrison did equally effective work with their "Caterpillars"* and kept open sections of the Boston Post Road, one of the vital arteries of motor traffic into Manhattan. Every community owning "Caterpillars"* is protected against the traffic tie-ups and the increased fire hazards of snow-blocked thoroughfares. Because of their sure footing and unfailing power, "Caterpillars"* will buck the deepest drifts and clear the snow faster and cheaper than any other method. They can be kept busy the year round grading and maintaining streets and roads. Let us show you our motion pictures of "Caterpillars"* plowing snow-blocked roads.

**There is but one "Caterpillar"—Holt builds it. The name was originated by this Company, and is our exclusive trade-mark registered in the U. S. Patent Office and in practically every country in the world.*

THE HOLT MANUFACTURING COMPANY, *Inc.*

Peoria, Illinois

Branches and service stations all over the world

Eastern Division, 50 Church St., New York

Omaha, Nebraska
Kansas City, Missouri
St. Louis, Missouri
Chicago, Illinois
Holt Company of Texas
Dallas, Texas

Des Moines, Iowa
Minneapolis, Minnesota
Indianapolis, Indiana
Canadian Holt Company, Ltd.
Montreal

EFFICIENT APPLICATION PERFECT DISTRIBUTION
SIMPLIFIED CONTROL

The ETNYRE Distributor in Action

Dependability
of
ETNYRE
DISTRIBUTORS
is your best
insurance.

UNIFORM DISTRIBUTION and thorough penetration are essential to good work and economy in applying liquid bituminous materials.

Both these requirements are fulfilled by the ETNYRE Self-heating Tar and Asphalt Distributor, which discharges through free-flowing spray-nozzles at an even pressure and constant volume.

It is a complete unit, mountable on any type truck, but independent in operation and control.

Full particulars sent without obligation

14TH NATIONAL
GOOD ROADS SHOW
UNDER THE AUSPICES
A·R·B·A·
COLISEUM, CHICAGO, ILL.
JAN. 15-19, 1923
VISIT OUR EXHIBIT

E. D. ETNYRE & COMPANY

Manufacturers of a Complete Line of Horse Drawn and Motor Driven FLUSHERS, SPRINKLERS, OIL, TAR and ASPHALT DISTRIBUTORS

OREGON, ILLINOIS

KOEHRING

What are the yardage factors ?

Speed in getting materials into the drum, and uniform mixed concrete on the subgrade.

—*speed,* which because of automatic actions, and simplified control can be *maintained* every minute of the working day.

—*speed which does not penalize by breakdown and delays.*

The Koehring paver is not only the mixer of speed in the chain of operations from charging skip to placement on the subgrade—but, it is the mixer of heavy duty construction that minimizes breakdowns and delays—that delivers at the season's end, the volume of low cost yardage which mean profits. Write for Koehring Paver catalog P 14

Capacities

Pavers: 7, 10, 14, 21, 32 cu. ft. mixed concrete. Write for catalog P 14

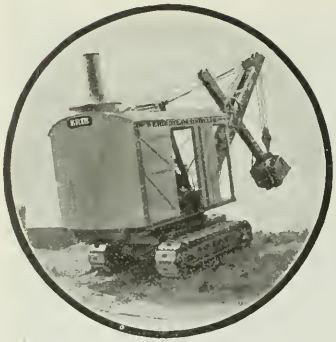
Construction Mixers: 10, 14, 21, 28 cu. ft. mixed concrete. Write for catalog C 14

Dandie: Light mixer, 4 and 7 cu. ft. mixed concrete; power charging skip, or low charging platform. Light duty hoist. Write for catalog D 14

KOEHRING COMPANY

MILWAUKEE WISCONSIN

Sales and service offices in all principal cities.
Service Warehouses in all parts of the U. S.



Not "How Much Should It Cost?" but— "How much DOES it cost?"

The buyer of excavating machinery is entitled to know the actual cost of steam shovel upkeep—***not merely five or six unusual records,*** but the averages of many shovels on a wide variety of work.

Upkeep costs are important to the steam shovel owner because of the direct repair expense that is involved—but far more important is the costly loss of time while repairs are being made.

A low repair-cost record spells ***steady operation,*** which is the finest feature of any good piece of construction machinery—the ability to work along week after week, and month after month, without tying up the job.

IN order to provide contractors with this essential information, ***the actual data on upkeep cost and steady service,*** we are offering prizes for the best records made by ¾ cu. yd. shovels which have received good care. We are going to award 20 prizes ranging from a first prize of $100.00 and a good gold watch, down to $5.00, in addition to $5.00 for each record that is published. (See list of prizes, at left.)

In order to avoid comparisons which might reflect unfavorably upon other makes of steam shovels, it has been decided to limit the entries to ERIE Shovels only.

How to enter the Contest

Records may be sent in by steam shovel owners, by managers, or any employee who is in direct contact with the shovel work—the superintendent, engineer, foreman or steam shovel operator. But in every case there must be a written statement by the owner of the machine, to the effect that the figures submitted are correct to the best of his knowledge.

Not more than one letter can be entered from one concern. If two or more entries covering different machines are received from one company, the best letter sent in will be considered. Contest closes December 31, 1922.

Information to be given in letter:

(1) Approximate number of days worked by shovel since put into service.

(2) Approximate number of cubic yards of material handled—stating how much classified as earth, how much rock, how much shale, etc.

(3) Total amount spent for repair parts. (Do not include dipper teeth, hoisting cable, or grate bars, as these are wearing parts which need replacement on any shovel that is working, even when it receives the best possible care.)

(4) Total lost time, during which the work was delayed for repairs to shovel.

Besides the above information, any additional details of interest should be included, together with one or more photographs of the shovel in action, if available.

Address your letter to A. C. Vicary, ***Vice-President,*** ERIE Steam Shovel Co., Erie, Pa.

If your firm does not own an ERIE and you cannot enter this contest, please refer this advertisement to someone who can act upon it. Thank you!

PRIZES:

FIRST PRIZE, $100.00 and a solid gold watch, 17 jewel Waltham movement, case engraved with winner's name and standing in contest.

SECOND PRIZE, $50.00 and a solid gold watch, 17 jewel Waltham movement, case engraved with winner's name.

THIRD PRIZE, $25.00 and a solid gold watch, 15 jewel Waltham movement, case engraved with winner's name.

FOURTH PRIZE.....$20.00
FIFTH PRIZE.....$15.00
SIXTH PRIZE.....$10.00
SEVENTH PRIZE.....$10.00
EIGHTH PRIZE.....$10.00
NINTH PRIZE.....$10.00
TENTH PRIZE.....$10.00
ELEVENTH to 20th PRIZES, inclusive, each..... $5.00

In addition to the above awards, $5.00 will be paid for each record that is published.

JUDGES:

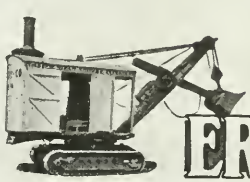
The letters will be rated, and the prizes awarded, by the following board of judges:

Arthur S. Bent, of Bent Brothers, Los Angeles, Calif., pioneer contractors on large hydro-electric and irrigation project construction; President of the Associated General Contractors of America.

Halbert P. Gillette, Editor of "Engineering and Contracting" magazine and author of "Handbook of Cost Data," "Earth Work and Its Cost" and many other engineering works.

Arthur C. Vicary, Vice President of the ERIE Steam Shovel Co.; mechanical engineer with many years of specialized experience on steam shovel work.

In making the awards, the judges will consider the actual record made by the shovel, and also interesting and informative details that are given in addition to the actual record. If two machinee were to make exactly the same record, the more interesting and informative letter would be given the higher rating; photographs also would be considered.



ERIE STEAM SHOVEL CO., Erie, Pa., U. S. A.

Incorporated 1883. Formerly BALL ENGINE CO.

Builders of ERIE Steam Shovels, Locomotive Cranes, Railway Ditchers,

Branch Offices: Boston, New York, Philadelphia, Pittsburgh, Chicago.

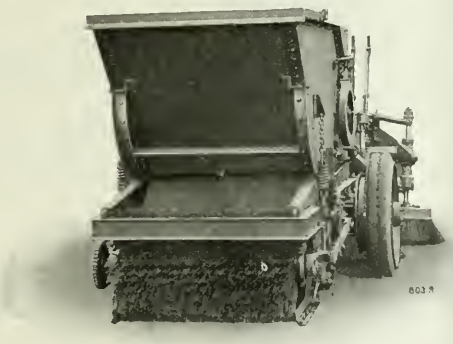
Representatives throughout the U. S. A.

Foreign Representatives:
Gaston & Co., 165 Broadway
New York City

ERIE Revolving Shovels

SPRINGFIELD

Motor Sweeper



A sweeper built to operate without mechanical trouble. Ball and roller bearing throughout. All steel brush construction with a brush life of months. Automatic rear discharge of load.

A prominent Eastern user says, "The sweeper purchased from you has been in constant service every working day, Sundays and holidays included, and giving perfect satisfaction."

For full information address

THE SPRINGFIELD MOTOR SWEEPER COMPANY

SPRINGFIELD, OHIO, U. S. A.

For PARKS and PRIVATE ESTATES

Texaco Asphalt Drive,
Geo. A. McKinlock Estate,
Lake Forest, Ill.

Just a few of the beautiful clubs, parks and private estates of America whose roads have been kept and maintained in ideal condition with TEXACO Asphalts and Road Oils:

The National Golf Links, Shinnecock Hills, Long Island, N. Y.

J. N. Hill Estate, Long Island, N. Y.

A. B. Dick Estate, Lake Forest, Ill.

New York State Park Reservation, Niagara Falls, N. Y.

Forest Park, St. Louis, Mo.

Geo. A. McKinlock Estate, Lake Forest, Ill.

Artemus Ward Estate, Long Island, N. Y.

The major portion of the 90-mile park drive and boulevard system of Kansas City, Mo., is Texaco paved.

Grove Park Section, Asheville, N. C.

TEXACO Asphalts and Road Oils make ideal roads for private estates.

Write for literature!

TEXACO ASPHALT

THE TEXAS COMPANY

Asphalt Sales Department

17 Battery Place, New York City

New York
Philadelphia
Richmond
Boston

Jacksonville
Atlanta
New Orleans
Memphis

Chicago
Cleveland
Oklahoma City
Kansas City

Houston
Dallas
Minneapolis

PUBLIC WORKS.

CITY COUNTY STATE

A Combination of "MUNICIPAL JOURNAL" and "CONTRACTING"

Vol. 53 December, 1922 No. 10

Garbage Collection and Disposal in Richmond

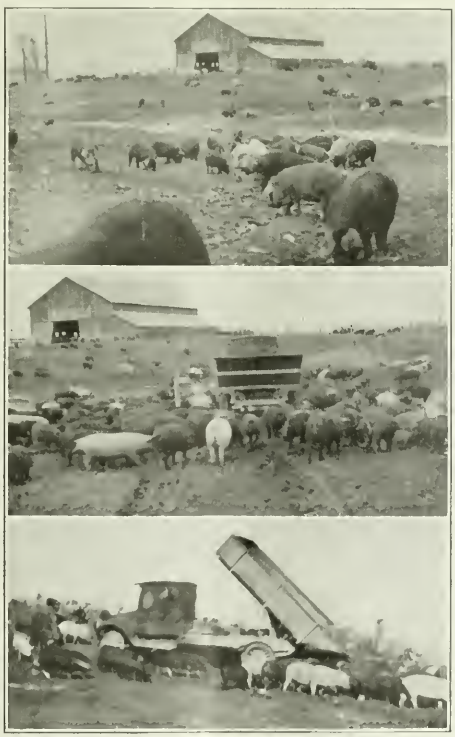
By D. B. Davis*

Garbage collected by city and transferred to hog raising contractor's truck by means of bins at incinerator, where that not suitable for feed is burned. Cost of collection and disposal.

Richmond, Indiana, is divided into four districts for the collection of garbage. Each district comprises an area of about one square mile and is served by a horse-drawn tank wagon of two cubic yard capacity, which collects the garbage twice each week during winter months and twice every ten days during summer. The garbage is collected from cans furnished by the householder. Garbage is emptied into the tank wagons and hauled to the incinerator, which is located in the river bottom, almost in the geographical center of the city. The collectors make two loads each day to the incinerator from each of their respective routes, although they are expected to keep their routes clean and cover them in the time mentioned above.

Prior to 1918 all garbage was burned in the incinerator. In February, 1915, a contract had been made with Henry H. Wagoner, of Huntington, Indiana, to install three separate units of Smith's patent garbage incinerator, each unit to have a daily capacity of six to ten tons of garbage. In 1917 the incinerator had become inadequate and the cost of fuel excessive. Garbage was then hauled to the country in the tank wagons, where it was given to the farmers for hog feed.

In 1919 a contract was let for both the collection and disposal of all garbage in the city. The contract price was $5,338 per year. The contractor collected and fed the garbage to hogs. The arrangement was not satisfactory to the city. Collections were intermittent and complaints numerous. In June, 1922, the city decided to take over the contract. They recognized the inadequacy of the incinerator and did not favor the burning of what they considered good hog-feed. An effort was made to interest large hog raisers with the view of having them take the garbage out of the city. No one, however, was familiar enough with the real value of the garbage as a hog feed to undertake the responsibility of giving bond to the city to remove it regularly. However, a bid was finally submitted by Jesse Druley for disposing of all the garbage collected by the city, the city to pay him $104.16 per month for the service. The city accepted it in preference to rebuilding the incinerator and going back to burning all the garbage.

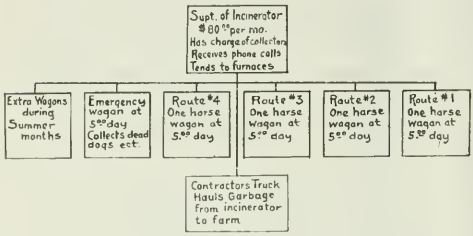


THE RICHMOND HOG FARM.
1—Before the garbage truck arrives. 2—400 hogs follow the truck. 3—Dumping the garbage.

*City Engineer of Richmond, Indiana.

The writer conceived the idea of making the present incinerator an exchange station, where the garbage collectors would bring the garbage to be transferred into the contractor's truck.

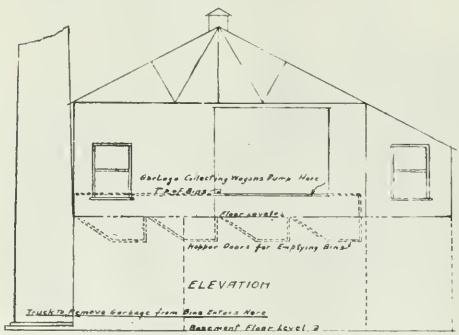
The incinerator is situated on a hill-side, which made it possible to build tanks, for the transfer of garbage, with hopper-dump bottoms, wherein the

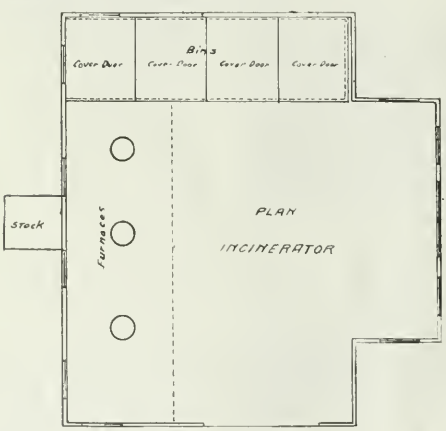

Supt. of Incinerator
$80.00 per mo.
Has charge of collectors
Receives phone calls
Tends to furnaces
Extra Wagons during Summer months
Emergency wagon at $5.00 day Collects dead dogs ect.
Route #4 One horse wagon at $5.00 day
Route #3 One horse wagon at $5.00 day
Route #2 One horse wagon at $5.00 day
Route #1 One horse wagon at $5.00 day
Contractors Truck Hauls Garbage from incinerator to farm

ORGANIZATION CHART.

city collectors could drive in above to empty their wagons and the contractor could drive below to fill his truck by gravity.

Four of these tanks were constructed, each with a capacity of nine cubic yards. Two tanks are all that is used at present, the other two being in reserve.





PLAN AND ELEVATION OF INCINERATOR, SHOWING BINS AND HOPPERS.

The underframing of the tanks was constructed from 3-inch I beams bolted together with ⅜-inch machine bolts. Four longitudinal and three lateral supports were used for each bottom section of the tanks. The sloping sides and bottoms are ⅜-inch boiler plate bolted to the underframing. The hopper doors are of a sliding type, giving an opening of 24 inches by 30 inches. The track on which the doors slide was constructed from 3½x6x3½-inch Z bars, with 3-inch channel bars bolted to the inside of one of the projecting angles of the Z bars, the channels being grooved so as to allow the placing of case-hardened steel rollers six inches on center. Bars were bolted to each of the two sides of the door to give a firm, smooth surface coming in contact with the rollers. When the tank is full of garbage, the doors can be slid open easily by hand. Wooden doors were constructed on the top, hinged at the back, with counter weights and cable attached for lifting them. Water drains from the garbage int drip pans which are connected with a sewer. The tanks are flushed each day and no odor is present.

The city does not collect garbage from wholesale fruit stands, groceries, meat shops or fish markets. This garbage is delivered to the incinerator by the respective proprietor's wagons, and, as it is largely unsuitable as hog feed, is dumped into the furnaces and burned at the city's expense. An average of 7 barrels of such material is so disposed of each week. Numerous dead cats and dogs also are burned.

The chart shows the organization of garbage collection and disposal.

The garbage is hauled by the contractor to the country, a distance of 6.8 miles, by a four-ton International truck equipped with an eight cubic yard Wood hoist body.

During July, August and September the truck made four large loads a day to the farm; during October and the first half of November it hauled three loads each day, while at present two loads a day will clean the tanks. The weight of an ordinary truck load of garbage is 5,800 lbs. net.

The approximate cost of operating the garbage truck per trip is as follows:

Driver at $3.00 per day (3 trips)	$1.00
5 gal. gasoline at 22c	1.10
Depreciation on $4,500 cost of truck	.70
Tires	.62
Oil	.03
Total cost per trip	$3.45

In August, Mr. Druley made an experiment to determine to his own satisfaction what hogs would gain on a purely garbage diet. Eighty-nine hogs were put in a ten-acre field containing no grass to speak of. They were fed one load of garbage (approximately 5,800 lbs.) each day with the necessary water. The lot of hogs were weighed prior to the test and each week thereafter for four weeks. At the expiration of 30 days each hog had gained an average of 1½ pounds per day during the test, or the 89 hogs had gained 133½ pounds per day. The price of hogs at that time was 8½ cents per pound, which made $11.35 per day increase from one load of garbage. The best gains known, by feeding hogs on corn and tankage, is two pounds per day.

At present, the garbage is fed in the field, al-

Total Annual Costs of Hauling and Disposal of Garbage

	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921
Hauling	$5,400	$6,300	$6,850	$5,600	$5,700	$5,600	$5,650	$5,450	$4,950	$5,500	$5,500
Coal	490	700	770	500	930	730	450	25	....	....	....
Total disposal	6,700	8,200	8,700	7,200	7,600	7,200	6,850	6,450	5,800	5,500	5,500
Total per capita	.29	.35	.36	.30	.31	.29	.27	.25	.22	.20	.20

though plans are in progress to have concrete feeding platforms built. Four hundred hogs are being fed on the garbage, although this summer, when four loads were secured each day, 735 hogs were fed

No sickness has occurred among the hogs since feeding the garbage. Attendants stated that the garbage had proved to be a food containing a mixed diet and one containing different elements necessary for gaining weight. It keeps the bowels open more readily than a corn diet and there is less liability for disease.

The pigs are vaccinated when about two months old. The cost of vaccination is approximately 30 to 35 cents per head, depending on the weight of the pig.

Editorial Note: It will be noticed in this article that the city not only collects the garbage at its own cost, but pays the contractor for taking it off its hands, although he uses it as feed for pigs. Two years ago pig raisers were quite generally paying cities for their garbage. This change of condition is commented on in the editorial column of this issue. It will also be noted that such garbage as is not used for feed is burned in the incinerator. We understand that the chief reason for discontinuing the burning of all the garbage was that the capacity of the plant was outgrown.

War Department Gives Nevada Draglines

The Nevada State Highway Department has just received from the Government, as surplus war material, three Thew gasoline-driven draglines. These machines, originally costing a large sum, have cost the State only a nominal sum for freight and handling charges and will prove of great value in stockpiling material and other construction activities.

Illinois Experimental Highway Tests

Results of tests discussed. Applicable only to highways with wet subgrades. The new Illinois cross-section. Bituminous base unfortunately not tested.

By CHARLES CARROLL BROWN, M., Am. Soc. C. E.*

Practically all of the sections of the Illinois Experimental Highway have been tested to destruction, only nine sections passing the final test without a break with four others which might have passed except for abnormal conditions, thus raising the number of satisfactory sections to thirteen. Of course, these abnormal conditions might have occurred in any of the sections, probably with similar results. Abnormal conditions also affected some of the sections which failed under the earlier and lighter loads of the test, affecting their relative position in a list of the sections made in the order of their durability as shown by the tests.

The News Bulletins issued by the Illinois Division of Highways after each test with given load give details of the action of the sections of pavement under each load until completely destroyed, so that it is possible to a certain extent to study each section in more or less detail and decide more or less accurately upon the reasons for failure in each case and upon the actual and the relative durability of each section. News Bulletin No. 7, issued under date of November 10, gives in addition a brief statement of the action and final condition of each section in order. It is accompanied by photographs of the sixty-three sections separately or in groups of two to five as they appeared on completion of the tests.

The writer inspected the road while under construction and saw the conditions of subsoil, drainage and pavement construction. This inspection was made late in December, 1920, and covered all the sections in completed form except a few of the concrete sections, the construction of which had been held up until spring by the arrival of freezing weather. Each section was described in some detail in two articles published in the numbers of Public Works for February 5 and 19, 1921.

At that time, it seemed that the location of the test road had been selected because of the bad conditions as to soil and drainage and that pavements which would be successful under the conditions there would be successful anywhere. The soil conditions are duplicated very generally in many parts of Illinois and Iowa, and less generally in other surrounding states where climatic conditions are similar. Drainage conditions approaching those at this location are not uncommon in Illinois. Indeed, they are much too general in that State to be conducive to durability of pavements unless the cost of them is increased. From the point of view of Illinois highway design and construction, therefore, the location undoubtedly has been chosen properly. Likewise the results of the tests are available for the worst conditions in other states. But it by no means follows that it will be necessary for other states to adopt for gen-

* Municipal Consultant, St. Petersburg, Fla.

eral application the plans developed by the Illinois Highway Division from these tests.

Thus far, the publication of results of the tests has been limited to the statements of facts ascertained. Doubtless the results will be analyzed later and the various materials and methods of construction will be compared and contrasted and the kinds and amounts of traffic for which they are individually suitable will be ascertained. Up to this time, the studies, at least so far as they have been published, have been restricted to the concrete sections and the only application of them has been to the design of a standard cross-section for concrete pavements.

In a letter from the heads of the Division to road contractors, the new cross-section is described and the reasons for its adoption are given. They are abstracted as follows:

The cross-section has a thickness of 9 inches at the edges of the pavement. This thickness is reduced uniformly until at 2 feet from each edge it becomes 6 inches and is uniformly 6 inches for the intervening portion of the slab. The bar reinforcement is the same as in last year's standard section, being ¾-inch round deformed-bars placed circumferentially 2 inches from the top of the slab and 6 inches in from the edges of the section with a 3-inch lap at the intersections; also ⅝-inch deformed-bars, 5 feet long and placed 10 feet apart which extend across the longitudinal joint along the center of the pavement. A new design has been made for the reinforcing structure of the longitudinal joint, which supports and joins the two halves of a slab at this longitudinal joint and locks with them and the transverse bars so that no vertical motion of one-half along the other is possible and so that they cannot move apart. This longitudinal reinforcement is adapted to the new 6-inch thickness of the slab in the central portion.

The greater thickness at the edges is deemed necessary because the tests showed that the strength at the edges is much less than at any other part of the slab. A thickness of 6 inches or even 5 inches is shown by the tests to give sufficient strength to carry loads up to the legal limit of weight of Illinois traffic. Nine inches thickness at the edges with the reinforcement makes them equivalent to the 6-inch thickness of the inner portion of the slab. Less than 9 inches is not sufficient. This new form of cross-section will be stronger than the former section with uniform depth of 7 inches, and with 18 feet width of road will require 195½ cu. yd. less concrete per mile. The saving in concrete will soon pay the expense of the tests which make it possible.

The writer visited the experimental highway in October, 1922, after the tests had been completed and while some supplementary tests were under way, and found under construction a section of pavement of the new standard design. It is understood that when this is fully cured, it will be subjected to the same measurements and tests as the other sections, that the efficiency of the design may be tested.

Really, an inspection of the tested pavements is necessary to understand fully the descriptions of results given in the official publications, and an attempt will be made in another article to valuate the various sections for various amounts and weights of traffic. For some sections, this can be done only by comparison of the official reports, but for the pavements having reasonably sufficient bases there was enough wearing surface left to give some basis for forming opinions even from the one inspection. The conclusions drawn will require further discussion and modification if and when those who have had the tests under frequent or constant inspection make more detailed reports. The comparisons of various sections made in News Bulletin No. 7 are scarcely detailed enough to give the impression of being more than the opinion of the assistant engineer who wrote the report and may not be worth any more than the writer's opinion, which is based, of course, on much less detailed inspection.

Of the nine sections considered to have passed the tests successfully and to be still in condition to carry traffic indefinitely, seven seem to be of concrete, one of asphaltic concrete on Portland cement concrete base and one of brick on Portland cement concrete base with bituminous filler. To these should be added three concrete sections and one asphaltic concrete on Portland cement base which had rather unimportant failures caused by defects outside the sections themselves. There were also one concrete section, two of bituminous filled brick on concrete base and two asphaltic concrete on concrete base with corner failures which were not typical and may be neglected.

Thus there are, according to the official report, 11 concrete sections, 4 asphaltic concrete sections, and 3 bituminous filled brick sections which may be considered to be fairly successful.

The regret that no bituminous bases were included in the program is made greater by the action of some of the bituminous and bituminous-filled pavements. The observed action of concrete slabs under temperature changes, described below, which was first discovered in this series of experiments, gives additional reason for testing this well-proven kind of base to ascertain its merits as compared with Portland cement concrete base.

The writer's prediction that, with the clay soil underlying this highway, the base of the pavement would always be wet, especially since there was no adequate drainage of the ditches in any part of the pavement, was more than justified. Water was always found on the subgrade under the pavement bases and slight holes scraped in the earth alongside the pavement would almost always fill with water which would flow off over the surface into the ditch if given opportunity. Since the capillary action of the clay will raise water several feet, it would be impossible to drain the water away by ditches and subsoil drains, and impractical to lift the pavement on a fill high enough to get it above the limit of this action. Gravel and broken stone are too expensive in many parts of Illinois to make it practicable to insert a layer of such material, above the level of the water in the ditches, thick enough to cut off this capillary action, but in other localities this might be more satisfactory than thick concrete, especially if comparative tests demonstrated that bituminous base were fairly near equivalent to Portland cement concrete base and considering also the fact that the bituminous base would lie more quietly on its bed.

The curling of rigid slabs on account of temperature changes, which these experiments show, changes daily from a lifting in the center with an increase in temperature to a lifting of the edges with a decrease

in temperature, is the new discovery. This accounts for longitutidinal cracks and for breaking down of slabs at the edges under heavy loads without taking any consideration of the effects of absorption of moisture, lifting by frost, or settlement by compacting or moving of subgrades softened by the absorption of water. Will the new standard cross-section of concrete pavement overcome the effects of this action? Does this discovery not point to the design and test of a more flexible foundation or of one which will not be so seriously affected by temperature changes? These seem to be the next directions in which investigations should be extended.

Although the lifting of the edges of the rigid slab pavements, which takes place at night or other periods of lower temperature, is slight, it is enough to give opportunity for full bending action of a heavy load on the edge of the pavement slab, and particularly on its corner. If the loads could be kept back from the edge far enough, the deflection of the outer portion of the slab would be slight enough so that the slabs would not be over strained and the truck wheel loads could be applied an indefinite number of times without fatigue of the concrete. This theory is shown to be correct by the results of the tests made after the date of modifying the program of tests by running the loaded trucks west on the north side on a line which kept the centers of the loaded wheels back from the edge of the pavement 2.5 feet, and returning on the south edge of the pavement with the wheels running as nearly as possible on a line 6 inches from the edge of the pavement and even at times, running off the edge of the pavement and back on again, to approximate the effect of turnouts onto shoulders when trucks pass each other on a narrow pavement. The north sides of the pavement slabs carried the loads with much less deterioration of the surface and base than did the south sides. Keeping the traffic off of the outer two feet or so of the pavement would probably have an effect approximating the proposed thickening of the edge. Evidently two feet width of 6-inch concrete would require more material than the proposed thickening, so that, unless traffic is sufficient to demand a wide pavement, say three or four lanes, and trucks can be kept on the inner lane or lanes, the thickening of the edges would cost less than the widening of the pavement. A regulation requiring trucks to keep inside a line drawn 2 to 2.5 feet from the edge might be enforced on a wide pavement, but could not be enforced on an 18-foot pavement, and probably not on a pavement less than 22 to 24 feet wide. Lighter vehicles would not overstrain the concrete if run nearer the edges. The thickening of the edges can be dispensed with, therefore, on the wider pavements under proper traffic regulations.

A report by H. F. Clemmer and C. A. Hogentogler, of the Illinois Division of Highways and the U. S. Bureau of Public Roads, respectively, goes into considerable detail on the distribution of wheel load on pavement sections and the effects of the load in developing strains in the slab, which is worthy of close study.

It is impossible in a single article to go into the details of the action of the various materials used in building the sections of pavement which were tested. They will be taken up in later issues.

Laying Vertical Fibre Brick

By Robert H. McKinley *

Methods of laying that are recommended as the result of experience. Specifications for filler and method of applying it.

"Vertical Fibre" brick pavement with an asphalt filler is by no means a new type of construction, but rather a selection from the many methods which have been used in the construction of brick pavements. Brick 3 inches deep by 4 inches wide by 8½ inches long are laid upon a 1-inch sand cushion over a suitable base of old macadam, rolled stone, gravel or concrete.

Experience has shown that the advantages of an asphalt filler are many. A flexible filler allows expansion and contraction without damage to the pavement and does away with the internal stresses of the brick wearing surface. It is easy to repair and low in maintenance cost. It is water-proof, quiet, smooth and easily cleaned.

The National Paving Brick Manufacturers' Association has adopted the following Asphalt Filler specifications as standard:

Section 1. Description: Asphalt filler shall be homogeneous, free from water, and shall not foam when heated to 200 deg. C. (392° F.). It shall meet the following requirements:

(1) Flash point—not less than 200° C. (392° F.)

*Chief engineer, Indiana Paving Brick Manufacturers' Association.

APPLYING ASPHALT FILLER TO VERTICAL FIBRE BRICK PAVEMENT IN KENOSHA, WIS

(2) Melting point (ring and ball)—
not less than 65° C (149° F.)
(3) Penetration at:
0° C. (32° F.), 200 grms., 1 min, not less than 10
25° C. (77° F.), 100 grms., 5 sec., 30 to 50
46° C. (115° F.), 50 grms., 5 sec., not more than 110
(4) Loss on Evaporation—
163° C. (325° F.), 5 hrs., less than 1.0%
(5) Ductility—not less than 3
(6) Total bitumen (soluble in carbon disulphide)—
not less than 99%
(7) Per cent. of total bitumen (soluble in carbon tetrachloride)—not less than 99%
(8) Reduction in penetration, at 25° C. (77° F.), due to heating specified under Loss on Evaporation—
not more than 50%

The above specifications insure a relatively high melting-point, adhesive and cohesive material which is malleable at low temperatures, yet retains its stability at high temperatures. It is a material which is not affected by summer heat sufficient to cause it to run out of the joints in the pavement, nor will it become brittle at low atmospheric temperatures, but will properly adhere to the brick, making the joints waterproof.

In filling the joints of a vertical fibre brick pavement the squeegee method is used, a light carpet coat of asphalt being retained on the surface of the brick which is covered with dry, coarse sand.

A question that arises in the minds of many engineers is that of filling all the joints completely. The brick are lugless, and there is the question of laying them so as to allow sufficient space around each brick to permit the asphalt filler to fill each joint completely from the bottom.

In this connection it is well to consider the brick, the laying and rolling.

It is impossible to manufacture a brick without kiln marks. With the old type of brick this was considered a disadvantage because these kiln marks appeared in the pavement surface, frequently causing a rough-finish surface. The "vertical fibre" brick is laid with the true wire-cut edge in the surface and the kiln marks in the joints, thereby providing a smooth brick surface with ample space in the joints for the asphalt filler.

In handling the brick the setter tries to place them so as to disturb the cushion as little as possible, but there is as a rule a small portion of the sand cushion that is caught between the brick as they are placed.

The brick having been inspected and the culls replaced, they are thoroughly swept and rolled. The roller starts at the curb and rolls forward and backward until it reaches the center of the pavement, then passes over to the opposite curb and rolls to the center. After both sides have been rolled in this manner the rolling is then finished by rolling at an angle to the curb. If the rolling is closely observed the brick will be seen to creep or move slightly. This creeping forces a small amount of sand into the joints, and should a few of the brick be removed it will be seen that in some places as much as a half inch of sand is in the joints, which holds the joints open, and a close inspection will show that there is sufficient space for the asphalt.

The asphalt filler should be heated in a kettle holding at least 250 gallons and whenever possible 500 gallons. The kettles should be equipped with thermometers, so that the temperature of the asphalt can be read easily at all times. The asphalt, which is shipped in drums or barrels, should be broken up into small pieces so as to about half fill the kettle, and a slow fire started in the fire box. When sufficient asphalt has been melted to cover the bottom of the kettle, the kettle can be completely charged, and the fire increased. The asphalt should be stirred at regular intervals throughout the heating to avoid burning, and should be maintained at a temperature of approximately 350 degrees F. during its application.

The brick surface having been swept clean, all joints are completely filled. The asphalt filler is applied to the joints by floating same over the surface of the brick with an iron or rubber squeegee. A wide-mouth pouring pot or a seamless coal bucket makes a very good container for use in applying the filler. The filler should be applied at right angles to the curb, and squeegeed back and forth in the direction of the pavement. Sufficient asphalt filler will remain on the surface of the brick to form a mat with the clean, dry covering material (usually coarse sand) which is then evenly spread over the surface.

The filler should be applied as soon after rolling as possible; and in no case should it be applied to wet brick, but in case of rain, the brick should be covered with tarpaulins in order to keep the joints dry. Each day's run of brick in place should be completely filled the same day.

The brick roadway may be opened to traffic immediately upon completion of the surface dressing.

Public Stairways

Many of the cities in this country are located on one or more hills with such steep grades, or with streets so laid out without sufficient consideration of the cross streets connecting them, as to necessitate the introduction of stairways for mounting from one street to another. In these

ASPHALT-FILLED BRICK PAVEMENT, ORANGE COUNTY, FLORIDA

cases, of course, wheel traffic is entirely excluded. In some instances these stairways have been provided by private funds, as, for instance, by a factory or other employer of large numbers of men, to enable these employees to reach the factory from their homes above or below it.

Probably few cities have a larger number of public stairways than St. Paul. The report of the Commissioner of public works of that city for last year gives a list of 85 stairways built and maintained by the city, the cost having been approximately $31,000.

Of these 85 stairways, 56 are constructed of wood, 19 of cement, 4 of stone, 4 of steel and 2 of reinforced concrete. They vary in number of steps from a minimum of 9 to a maximum of 195. The total difference in elevation between the top and bottom of the stairway averages 33-1/2 feet. Two of these were built in 1887, one of wood and the other of stone, and one of wood in 1892, but all the others have been built since 1900.

The width of the steps varies from a minimum of 3 feet to a maximum of 18 feet, the greater number of them being either 4 or 6 feet. The rise of step varies from a minimum of 4-3/8 inches to a maximum of 9 inches, but only four have the latter height, the great majority being either 6 or 7. The tread varies from a minimum of 8 inches to a maximum of 15, only twelve being more than 12 inches.

These stairs are of all degrees of elaborateness, from a wooden one of 15 steps costing $20 to a stone one of 48 steps costing $4,675. The average construction cost of all the materials was about $11 per foot of rise, or $365 per stairway.

Road Oiling in Wyoming

The November 1st issue of the "Bulletin" of the Wyoming State Highway Department contains an article by the District Engineer of the Second District, R. J. Templeton, entitled "The Experiment with Road Oil," from which we learn that during the past summer the State Highway Department has been experimenting with the use of road oil. Said he: "It will probably be several years before Wyoming is ready to start in hard surfacing roads on a large scale and in the meantime we must make the best we can of our dirt, gravelled and shaled roads, by keeping a smooth wearing surface to the already well built subgrade."

To eastern cities it seems odd to think of considering the use of oil as an experiment, and especially in a state which, Mr. Templeton says, "is rapidly coming to the front as an oil producer."

The department purchased an oil distributor mounted on a Kelly 3-ton truck chassis. The oil was distributed on one section having a gravelled section with poor binder and on another having a shaled surface. About one-half gallon per square yard was applied at 40 pounds per square inch pressure and 200 degrees temperature. After oiling, a coating of fine gravel was spread. The oil, after having been on a month, was found to be binding the surface material and keeping the dust down. On this experiment "will probably depend what part Wyoming oil will play in the surface treatment of Wyoming State roads."

Use of Base Before It Sets

It is generally considered that concrete, whether as base, as filler or as wearing surface, should be allowed to set for seven days or more before traffic is permitted over it. The pavement referred to below, however, apparently suffered no injury, although the blocks were laid on the base when but a few hours old and the pavement thrown open to traffic.

November 13, 1922.

The Editor, Municipal Journal,
New York City.

Sir:

In your issue of August 30, 1919, you called attention to the laying of granite block pavement in Seventh Avenue, Borough of Manhattan, New York City, on concrete foundation, some of which was only twenty-eight hours old.

This was done after careful consideration by the contractor and the writer, who was in charge of the work, in view of the intense traffic to and from the Pennsylvania Station, practically all of which is, however, rubber-tired automobiles.

An examination of the surface of this pavement, now three years old, will, I know, show that our decision has been justified, and will also show a remarkably fine piece of granite pavement for the entire length of the contract—30th Street to 42d Street.

It might be said that, as a basis for the decision, we had experience proving that twenty-four-hour concrete often carries considerable steel-tired traffic without any protection from a wearing surface. This is not to be considered desirable, but occurs in spite of precautions.

Yours,
R. A. MacGREGOR,
Assistant Engineer, Department of Public Works.

Questionnaires for Bidders

The Commissioners Court of Dallas County, Texas, this season adopted a policy of requiring bidders on road work in that county to answer a questionnaire regarding their experience, equipment available and financial condition. The commissioners assert that, while the lowest bid is easily determined, the statute requires that contract shall be awarded to the bidder submitting the "lowest and best bid," and that the latter can be determined only by some such method as this questionnaire.

The questionnaires were distributed to seven bidders on one project involving about $600,000, and no objection was raised at the time and the questionnaires were answered, but some of the contractors have since been complaining against what they call "this unwarranted method."

The contractor is required to give his experience in constructing roads, the equipment which he possesses available for this contract, whether he intends to sublet part of the work, and his financial ability to carry through the contract. The equipment questionnaire is the simplest, merely calling for a list of all articles of road machinery available for use on the project in question, listing these by name, type, size or capacity, and present value. The financial questionnaire requires the bidder to list his assets as cash in bank with name and location of bank, amount of other cash available, cash value of equipment, cash value of stocks and bonds, of notes receivable,

of accounts receivable, and of all personal and real property. Under liabilities are to be listed all outstanding unsecured notes, outstanding mortgage or lien notes and outstanding accounts.

Some of the questions are: "What banks or bankers do you give as reference?" "How much credit will these banks or bankers extend you on this contract?" "Do you meet all obligations promptly and discount your bills?" "Have you ever been insolvent or bankrupt?" "Have you ever failed to complete a contract on account of lack of financial ability?" "How many years' experience have you had in highway construction as general contractor or sub-contractor?" "On what types of construction have you been engaged?" "Have you ever done any work for the United States Government?" "For what state highway department have you performed work and to whom do you refer?" "Under what county have you performed work and to whom do you refer?" "For what corporation or individual have you performed work?" "Do you complete all your work on contract time, unforeseen contingencies allowed for?" " What is the largest contract you ever had and where, giving in detail types of construction, etc?" "Have you a going organization now ready to place on this project?" "If not, how soon can you perfect an efficient organization?"

Economical Control of Chemical Dosage in Filter Plants*

Methods whereby selection of chemicals and details of applying them may be altered to reduce their cost without a sacrifice of results.

By R. A. Maddock†

Usually when city officials engage or consider engaging a man who has had special training and experience in water purification, they are prompted to do so by what they believe he will be able to save for them in dollars and cents rather than that which is of infinitely greater importance,—a safe, pure water supply at all times.

It is fortunate for all of us that in a great many plants (especially in the smaller cities), the opportunity really exists to reduce operating expenses. Our more progressive city officials are beginning to realize that the proper operation of a water purification plant not only consists of hydraulics and mechanics, but is a problem of biology, bacteriology and chemistry as well, and are giving more encouragement to laboratory control.

Perhaps one of the greatest opporunities that usually exists to reduce operating expenses is in the control of chemical dosage. The point of application, agitation and hydrogen-ion concentration, all have an important bearing on economical coagulation and sedimentation, over which the operator usually has control. By careful and intelligent handling, the hydrogen-ion concentration can be adjusted to the optimum PH value, which is necessary for complete or nearly complete precipitation of the aluminum from the alum added to the water, which means less chemicals will be required for a given bacterial, turbidity or color removal. This point has not been very definitely esablished as yet, and the reports from various sections would indicate that it varies for different waters.

Very often the chemicals are introduced into the main just before reaching the sedimentation basin, and while this method is satisfactory under most conditions, it will at times be found an advantage to apply the chemicals at some other point or at several points. If the water to be treated contains much heavy sediment, it would be a waste of money to apply the chemicals before the water enters the basin, since a large portion would be carried down with the heavy particles soon after entering the basin. Under conditions of this kind it would often be found advantageous to let the heavy particles settle out in the first part of the basin without the aid of coagulation, and apply the chemicals at or near the center of the basin if capacity will permit.

In many plants it is necessary to use quicklime (calcium oxid) in connection with sulphate of alumina. To get the best results from its use it should be slacked very carefully. Hot water will be found best for this purpose as the temperature during slacking should be as high as possible.

We know that the temperature of all surface waters fluctuates and that temperature has a marked effect upon coagulation, which is another reason that provisions should be made to apply the chemicals at different points. The proper time to install provisions of this kind is when the plant is built. With all kind feelings, I am prompted to say that we have too many designing engineers who are entirely too unfamiliar with the plant operation end of it. On a great many occasions the credit for a plant that is operated with apparently good results has gone to the engineer when it rightfully belonged to the plant operator.

A method is being installed in the new water treatment plant at Newark, Ohio, which was designed by Charles P. Hoover, assisted by A. R. Hol-

*Paper before N. C. Section, A. W. W. A., at Gastonia, N. C., November 14-16.

†Chemist and bacteriologist in charge of water purification, Charlotte, N. C.

brook, which consists of excess treatment with lime, soda ash and alum, combined. This excess treatment will be obtained by overdosing a portion of the supply and subsequently mixing it with a larger and untreated part of the supply. The amount to be treated with excess amount of chemicals will be approximately twenty-five per cent, immediately after which it will be vigorously agitated for about five minutes. This twenty-five per cent portion will then be mixed with the seventy-five per cent untreated portion in a baffled mixing tank, through which the water will have a carrying velocity of 0.4 ft. per second, the detention period being sixty minutes. The entire body of water will then be passed to concentrating tanks equipped with Dorr thickeners, where the water will remain for about twenty-two minutes. It is pointed out by Mr. Hoover that the extraction of as much as possible of the precipitate or sludge in the thickeners before the water passes to the sedimentation basin will lessen the accumulation of sludge at the entrance of the basin and thus make the basin utilizable to its full capacity at all times. It is believed that this method will prove to be economical as well as efficient.

While the carbonation of water as an aid of coagulation is more or less in the experimental state, it has been reported on very favorably.

John R. Baylis, principal sanitary chemist, Water Department, Baltimore, Md., has recently reported that at Baltimore the addition of a small amount of sulphuric acid to the water before, or at the same time as the alum, has aided coagulation very materially. He reports that several trials have been made under operating conditions with results that show considerable saving in alum. From this experimental work Mr. Baylis draws the conclusion that in most places an acid alum could be used with better results than basic alum, which is being used almost universally.

The waters in some lakes and a few rivers, especially at certain seasons of the year, are comparatively free from coloring and suspended matter and could be treated very successfully, the writer believes, with a method he used at Oshkosh, Wisconsin, for about two years, and which resulted in a large saving of chemicals. Oshkosh gets its water supply from Lake Winnebago, which during several months of the year has very little coloring or suspended matter. The method used during these favorable periods is described as follows: Discontinue the application of chemicals to the sedimentation basin and instead apply a strong solution of sulphate of alumina to the quiescent water in a freshly washed filter bed and allow to stand long enough to break up and form a mat of aluminum hydroxide of a uniform thickness. Some of you will remember a few years ago when asbestos was tried out to produce a filtering mat on the surface of the sand but was a failure due to inability to get a uniform thickness. The amount of sulphate of alumina used depends upon the strength of the solution as well as the area of the sand bed. This solution can be applied through an ordinary garden hose but was applied at Oshkosh through perforated pipes placed over the filters at regular intervals. This method does away with any chance to get alum in the filter effluent and provides a good mat from the very beginning of each filter run. The writer believes this method could be successfully used at a great many plants,—at least periodically.

It has been observed at some few places that chlorination preceding the addition of alum has very greatly aided coagulation in removing both suspended and coloring matter. The application of chlorine prior to filtration is, the writer believes, in many instances good practice, since where bacterial removal alone is sought by the use of alum, to produce an effluent from the filters that will compare favorably to the American Public Health Standard, the substitution of chlorine for alum will be found an effective substitute.

Should a plant operator be classed as careless or incapable because he does not strive to produce a low bacterial count in the effluent from the filters, but who regulates his chemical dosage so as to get a water that is free from suspended matter and depend on chlorination for satisfactory bacterial count? In a great many cases the answer to this question should be "no." Many of those who favor treating the water with sufficient chemicals so as to obtain an effluent that will pass the U. S. Health Standard before chlorination, seem to think that it is unsafe to rely upon chlorine to do its full and just share. This is probably true for the plant that is inefficiently operated and that relies on one chlorinating outfit. All plants should have two complete chlorinating units with a supply of all extra parts on hand so in case one machine goes down and out there need be no delay or interruption in the sterilization of the water. In the larger plants both chlorinators should be allowed to run with the dose divided equally between them.

Proper installation of chlorinators and same operated in multiple units is all that some of our larger cities depend on for the successful purification of their water supply. Of course, chlorinators require intelligent supervision the same as any other mechanical device.

Some few engineers go so far as to contend that chlorine should not be used at all. From the standpoint of economy it seems to me that it is poor business as well as poor judgment to spend four dollars to purify a million gallons of water without the use of chlorine when the same standard of purity can be maintained for two dollars by using chlorine in connection with coagulation and filtration. On the other hand, to insure a constant supply of pure water depending at all times entirely on coagulation and filtration, would in most cases require a trained man on the job every hour of the day and night, which is a condition found only in our largest cities.

In a number of cases chlorination has enabled the rate of filtration to be increased. This increased capacity which otherwise would have called for additional filter units, has been obtained without any further costs.

It is constantly being demonstrated that it is possible to successfully operate water purification plants to obtain the desired clarification and color removal by the use of alum, and rely on chlorination for bacterial removal.

The writer believes that using chlorine on the side of safety is the proper thing to do when treating

such waters as those that show a satisfacory bacterial count when treated to produce one hundred per cent clarification and a satisfactory color removal. However, I believe that in limiting the use of chlorine only as a measure on the side of safety, we are not making proper use of the greatest instrument ever placed in the hands of water purification engineers.

We plant operators are too often inclined to accept the other fellow's word for it that a certain thing will or will not work. The writer believes this in many cases to be decidedly wrong since the conditions under which the other fellow is working may be entirely different from our own.

At Charlotte we have been able to reduce operating expenses about $6,500 per year.

Some one has said that "eternal vigilance is the price of pure water," and in controlling the purity of public water supplies, laboratory control is far more economical and surely more efficient than any other method known.

Oil Pollution of Waters

The pollution of water by oil, while not carrying with it the danger to life that is contributed by sewage pollution, from a point of view of nuisance bids fair to far surpass it. It is found that apparently the oil pollution of waters in harbors and along the coast is due to oil burning and oil carrying steamships, and as the use of these is increasing, the oil nuisance threatens to similarly increase unless something is done to prevent it.

The presence of the oil floating upon the water is not only objectionable to the sight and smell, but it is practically ruining the bathing beaches in the vicinity of all large cities, and is a source of danger from fire. Already several fires have started in oil floating in the various harbors and have threatened and in some cases set fire to the ships. Where oil occurs in any large quantities continuously it drives away fish of all kinds and also shore birds.

Sea Water and Wells

The results of a survey made in 1919 of the ground water obtained by wells on a 30-mile stretch of coast in Connecticut is given in the October number of the "American Journal of Science," supplemented by information concerning wells on the Florida coast and some obtained by foreign investigations.

On the section of the Connecticut coast referred to, which lies east and west of New Haven, shallow wells are affected by salt water for only a short distance from the shore, the maximum distance at which even slight contamination was detected being 250 feet. If, however, natural conditions are disturbed by heavy pumping or otherwise, the sea water may travel inland for a considerable distance.

Even at short distances from the shore contamination was not universal. Of thirteen wells less than twenty-five feet from the high-tide shore line, only four showed more than 300 parts per million of chlorine, two from 100 to 300 parts and three from 25 to 100 parts, the other four wells showing no contamination by sea water. Of seventeen wells lying from 26 to 50 feet beyond the shore line, nine showed no contamination. Of 31 lying between 200 and 500 feet, only one showed any contamination and that merely a trace of chlorine.

Twenty-nine wells from 100 to 300 feet deep were examined, most of them 6-inch wells and nearly all penetrating bed rock. Of these, ten showed positive contamination by sea water and two others probable. It was concluded that the depth of well along this coast should not be greater than its distance from the high-tide shore line.

Conditions on islands do not appear to differ materially from those on the mainland, but in tidal marshes the ground water is brackish and is salty in bars and spits.

As has been shown by many other investigations, it was apparent from these that if the water was drawn through wells and exceeded that flowing toward the ocean from the catchment area behind, water will be drawn from the ocean and contaminate the flow from the wells. Inspection of twenty-three plants pumping from wells and located within 500 feet of the shore along this Connecticut coast showed ten drawing highly contaminated water and four others slightly contaminated.

Apparently the rise and fall of tide had no effect on the contamination of wells from the ocean, but there were periodic fluctuations of salinity at intervals of days and weeks, varying with the amount by which the water in the well was lowered below the ocean level.

Hail Causes a Canal Break

The Reclamation Service of the Department of the Interior publishes an account of a break in a canal with an unusual cause, hail being the primary agent.

A cloudburst occurred in the Little Bitterroot river valley of the Flathead Project on August 30, beginning with hail, followed by rain. This storm crossed the upper half mile of the Camas A canal and swept through a small area of dry farming country, destroying gardens and such grain crops as were not yet harvested, washing out roads and small bridges and culverts on the road to Hubbart reservoir.

The canal is located at the foot of steep mountain slopes, which are heavily timbered with pine, fir, and tamarack. The hail storm which preceded the rain clipped small branches from the trees and the flood from the heavy rain swept the branches and hailstones down the slopes into the canal. Sand and gravel were also carried into the canal from coulees, where the flow of water collected. The canal, which is 150 second-feet capacity, was filled entirely to the top of the bank with hailstones packed in the pine needles and branches. A small head of water running in the canal was forced over the bank, causing a small break. On account of the protection afforded the hail from the needles and branches, the process of melting was slow and it was necessary to shovel out a channel after cleaning out the sand and gravel bars with team forces, in order to get water through the canal. Some of the hailstones were more than two inches in diameter.

Cost of Sewer Joints in Wet Trenches

By M. H. WALSER *

Tight sewers obtained by use of special jointing material and jointing form, although water was flowing six inches deep through sewer during construction.

The normal stage of the Mississippi River at Fort Madison, Iowa, prior to the construction of the Keokuk Dam was twelve feet in the spring with an extreme of sixteen feet once in twenty years. This allowed drainage from the entire city and a patchwork of independent sewer systems had been constructed from time to time, which operated more or less satisfactorily excepting during the short periods of extreme high water. By the completion of the dam, located twenty-four miles down the river, Lake Cooper was created and the water level was raised to 16 feet, causing the existing sewer systems to become, in a measure, inoperative.

In 1916 the city employed the Burns & McDonnell Engineering Co. to make surveys and plans for a comprehensive sanitary sewer system, separating the domestic sewage from the storm drainage. The system as designed consists of four distinct portions, three serving the higher parts of the city through gravity outlets above high water and one serving the lower part along the lake through a pumping outlet. Contract for the construction was awarded in June, 1920 to the National Construction Co., of Davenport, Iowa, and work on the pumping system was started one year later with the writer as engineer in charge. Construction was completed in March, 1922.

The pumping system consists of 4.2 miles of eight-inch (8″) to twenty-four-inch (24″) pipe of which 3.4 miles was laid in wet trenches. The low point in this system was at an elevation of 8 feet below the water level in the lake and the floor of the ejector pit in the pumping station was at an elevation 14 feet below the water level. The ejector equipment consists of three 150-gal. P. F. T. ejectors. Air for the operation of the ejectors is supplied with two I. R. single-stage compressors driven by 7½ h. p. motors. The operation is nearly automatic and requires ordinarily only attention for oiling and inspection. The total cost of the low lines was $128,000 and the ejector pumping station with equipment cost $38,000 more.

The lines tributary to the pumping station were all below the level of the lake and in water-bearing gravel and quicksand, and the conditions encountered during construction were such, and the usual water flow was so large, that ordinary mortar joints were out of the question, and experiments were made with various types of joints to select the most suitable. The character of the ground was such that sub-drains were not likely to be of any benefit, and the flow of water was too great to handle in the open trench, so that it was found necessary to allow the water to flow through the pipe to a central point for pumping. The depth of this water was at times half the diameter of the pipe being laid, and the flow in the invert of the tile was never less than three to four inches deep. Conditions were encountered where the sand would boil up from the bottom of the trench and completely cover the pipe being laid. This was accompanied by a subsidence of the surface and quite frequently braces against the sheathing were necessary to hold the pipe to grade and line.

It was early evident that especial care would have to be taken to prevent excessive leakage and it was most desirable to reduce this leakage to a minimum, as all infiltrate as well as sewage had to be pumped up in to the river. A joint developed by the writer for joining the larger sized pipe was first used. This joint consisted of hot asphaltic compound poured into the bell of the pipe together with a concrete cradle to complete the joint. These joints were poured with six to eight inches of water flowing through the pipe and when properly made gave a completely watertight joint. Later the Weston Form and Gasket was tried on this size of pipe and about one-third of the total twenty-four-inch pipe was laid with that joint.

There was very little difference in the cost of laying the two types of joint and the speed of laying, depending largely on the difficulty of getting trench opened up, was about the same. Both types developed about the same amount of faults, and failures due to indifference on the part of the workmen were common to both. For the smaller sizes of pipe a combination of Weston form and gasket and a poured joint of asphaltic compound were used, affording the writer the opportunity to collect some very interesting data as to the comparative cost of laying pipe with these types of joint.

The method of laying was as follows: Two joints of pipe were joined on the surface, using asphaltic compound. These joints were poured ahead of the work of laying and were handled into the trench as one pipe five feet long. One pipe was stood on end with the bell end up and another pipe was centered into it. A small amount of jute was then caulked into the bell and hot asphaltic compound was poured until the bell was entirely filled. The pipe was left standing until needed and no difficulty was experienced in handling, as the compound when cold had suffi-

*Of Burns & McDonnell Engineering Co., Kansas City, Mo.

cient strength that the two pipes could be handled as one single pipe without danger of the joint giving way.

For this work 17,585 pounds of compound costing $818.91 at the work was used. Approximately 8 pounds was used in pouring an eighteen inch (18″) joint; 6 pounds for for a fifteen-inch (15″) joint; and three pounds for an eight-inch (8″) joint. The labor of setting up, caulking and pouring was 0.102 man-hour for 18″ pipe and 0.065 man-hour for 15″ pipe per foot of tile laid. Usually two men worked together on this work and also inspected pipe for flaws before setting up.

As only two pipes could be joined on top without too great length for convenient handiing, every other joint had necessarily to be made in the trench. For this work Weston forms and gaskets were used with a 1:1 cement grout.

These forms consist first of a gasket constructed of sheet iron arranged to fit around the spigot end of the tile in such manner that the opening between the bell and spigot is nearly closed. Then there is a form also constructed of sheet iron that goes on outside the bell and around the lower half of the tile into which the grout is poured to make the lower half of the joint. This form is left in place and the top part of the joint, being out of the water ,is made in the usual manner. Pumping was continued for about two hours after laying, when the water was allowed to come up and cover the pipe.

The cost of laying these joints varied greatly with the depth of trench and class of material in the trench bottom, but averaged 0.4 man-hour for 15″ tile and 0.7 man-hour for 18″ tile in sand and gravel bottom, and 0.45 man-hour for 15″ and 0.8 man-hour for 18″ tile in quicksand, per foot of tile laid.

These costs include only the pipe-laying crew consisting of pipe-layer, grader, assistant grader to handle pipe, jointmaker and mortar mixer. The jointer assisted the pipe-layer in handling the pipe in the trench and usually completed the last joint by the time the trench was ready for the laying of the next section. This is in a trench partly dug with a Parsons' excavator and finished with a clam-shell and is in decided contrast to the cost of laying the same tile in a trench dug by hand, which averaged 0.25 man-hour per foot of 15″ tile laid.

Mortar for joints was mixed with equal volumes of cement and sand and was poured rather wet from a specially constructed pouring can. An average of 0.082 cubic foot of mortar was used per foot of 15″ tile at a cost of 3.4 cents per foot, while 1.2 pounds of compound per foot was used at a cost of 3.9 cents; this shows a slight saving in favor of the mortar joint without considering the cost of the Weston forms, which had to be left in the trench and which cost 10.5 cents per foot of tile for both form and gasket. In addition, it is interesting to note how the alternate joint poured on the surface at a cost in labor of 0.065 man-hour per foot compares with the next joint poured in the trench at a cost in labor of 0.4 to 0.45 man-hour per foot of tile laid, an evident saving on each surface poured joint of not less than 0.3 man-hour per foot of tile laid.

That the methods used were reasonably successful is evidenced by the fact that after completion, the infiltration amounted to only 85 gallons per minute for the entire 4.2 miles of deep line, a very reasonable amount considering the exceptionally difficult construction.

Activated Sludge for Packing House Waste at Mason City

A plant installed last year for disposing of packing house waste at Mason City, Iowa, by the activated sludge process has been described by Edward Bartow in a paper before the Iowa Engineering Society, from which the following is abstracted.

In March of 1921 the District Court ordered Jacob E. Decker and Sons, packers, of Mason City, to provide some method of so treating their waste as to improve the condition of Lime Creek within thirty days. An extension of time was of course necessary, but the plant was constructed and put into operation as rapidly as possible. Investigations already made by the Sanitary District of Chicago and the packers at the Union Stock Yards had indicated that the activated sludge process was most desirable for treating packing house waste liquors, which contained blood, grease, hair and other organic matters, and it was believed that the same would hold true at Mason City.

Owing to the short time allowed for investigation, a plant was designed which could be enlarged readily if it should prove inadequate, although a larger plant was provided than would be considered necessary for ordinary municipal sewage. It was recommended that there be constructed an aeration unit 39 feet wide, 48 feet long and 15 feet deep, which would give about eight hours detention with 6,000 gallons flow daily and a 25% sludge return.

The plant contains a house for the sewage pumps and air compressors, the aerating tank and a settling tank. All the waste from the packing house is brought to a sump containing two compartments, from either of which it can be pumped by centrifugal pumps into a grease tank, which is 6 feet wide at the surface, 4 feet deep at the shallow side, and slopes to 8 feet on the outer and deeper side. From the latter side, openings controlled by valves lead to a sump from which the sludge can be forced by compressed air to the byproducts house.

From this grease tank the liquid flows to the aeration chamber, and passes four times the length of this chamber after it has been mixed

with activated sludge. Two No. 6 Hytor air compressors built by the Nash Engineering Company, with variable speed motors, furnish air for the plant, having a capacity of from 650 to 2,200 cubic feet of air per minute, or nearly 4 cubic feet of air per gallon of sewage. The air is blown into the sewage through Filtros plates placed at right angles to the line of flow in rows 6 feet apart so that the plates cover about 20% of the area of the tank. Between the plates, the bottom is elevated so that the settling sludge will fall toward the plates and be carried to the surface by the incoming air. This aerating chamber has a capacity of approximately 155,000 gallons, so that, with a flow of 300,000 gallons with 30% sludge returned, there will be a detention period of 9 hours.

From the aerating tank the mixed sewage and sludge passes to a settling tank, a Dorr thickener 36 feet in diameter being used for this. This tank is built of reinforced concrete 14 feet deep and with the bottom sloping slightly toward the center. At the center the sludge drops by gravity into an air-lift well, from which it is pumped by air-lift to the mixing box at the end of the grease tank. One-quarter of the circumference of this tank is depressed, and the effluent from this tank leaves over the depressions, which were made by placing 2 x 4s every 16 inches in the form into which the concrete was poured. The distribution of the flow is found to be more satisfactory than in cases where the entire circumference is used for the overflow.

This plant was put into operation in October, 1921, and improvement in the effluent was noticeable at once and within ten days a satisfactory sludge had developed so that a clear and fairly stable effluent was obtained.

Some trouble was experienced after a Sunday shut-down owing, it was believed, to the rather large settling capacity. This was remedied by returning the sludge at the same rate during the shut-down as during the period of maximum operation. It is thought probable that the addition of sufficient water to form a current through the settling basin would prevent putrefaction during a shut-down.

It is proposed to pump the sludge to tanks in the by-products house, add sulphuric acid which will cause the suspended matter to rise to the surface, when the clear liquid will be drawn off from the bottom and the sludge concentrated with the tankage.

During last winter the plant did not give good satisfaction, either because of the greater number of hogs killed, or because of the cold weather; but during the latter half of March the plant again began giving good results.

Land Disposal of Liquid Sludge

Wet sludge is being disposed of on land at Blackburn, England. At first sewage irrigation was tried, but as the area of land became insufficient, a sludge-pressing plant was installed in 1897. Dortmund tanks, which were put into service soon after this, produced a sludge which did not work satisfactorily in sludge presses, even when large quantities of lime were added. Beginning with 1909 experiments were made in pumping the humus sludge from these tanks directly on to the land formerly used for broad irrigation, and following these, pressing sludge was finally abandoned and the distribution of the wet sludge directly on the land has been employed.

Distributing trenches following the contours of the land carry the sludge on to the area used. Thirty-six thousand tons of sludge were distributed in this way during the past year at an average rate of 120 tons or 26,880 gallons per acre, or a depth of something over one inch over the entire surface. The cost for labor for cutting the trenches and secondary distributing channels and generally handling the distribution is about ten cents per ton of wet sludge.

Dangerous Gas in Sewage Filters

A correspondent of the English paper, "Municipal Engineering and the Sanitary Record," Arthur J. Martin writes to that paper that during July one of his assistants who was examining the alternating gear of a contact filter was rendered nearly unconscious by carbon dioxide gas. Mr. Martin stated that in his experience of 26 years he had never heard of a previous case of this kind, although the manager of the plant in question had had a similar experience.

Explaining this, Mr. Martin says that a sewage filter in oxidyzing carbon produces carbonic acid gas which, being heavier than air, sinks to the bottom of the filter and passes off through the underdrains. Where these have a free outlet the gas will flow off with the effluent as fast as it is produced; but where the drains converge in a central chamber, the outlet from which is submerged or otherwise trapped, the gas may be unable to escape and will accumulate in the lower part of the chamber. He, therefore, suggested that those who have occasion to work in chambers in which this gas is liable to collect should not stoop down in them without testing the air in the bottom of the chamber by means of a light.

Chlorinating Sewage at Selma

The sewage of Selma, North Carolina, is treated by disinfection in a plant designed by William M. Piatt in 1921. The plant is contained in a building 20 feet by 10 feet, inside dimensions. The sewage first passes through two basket screens which catch the gross inorganic solids. From the screens the sewage passes into what is called an attrition chamber, the purpose being to hold the organic solids in this chamber until they have been thoroughly broken up before passing them into the disinfection chamber. This chamber has a hopper-shaped bottom, in the bottom of which is a clean-out opening with a pipe leading to the river and controlled by a valve.

The sewage leaves the attrition chamber through a 6-inch pipe about a foot below normal

water level, which carries it into the disinfection chamber. This chamber is provided with two baffle walls extending from the top of the tank to within 2 feet of the bottom, and between these a third baffle extending from the bottom 7½ feet high to within 2 feet 8" of the normal water level. The chlorine and sewage are both introduced behind one of the end baffles, and the mixture is effected while the sewage flows under this baffle over the middle one and under the other end baffle, then leaving through an 8-inch pipe to the river.

In entering the attrition chamber the sewage is directed down one of the slopes of the hopper bottom with a view to continually agitating any matter that may have settled out of the sewage and produce a comminution or attrition of the solids in the sewer. Floating matters are usually arrested in the attrition chamber by the submergence of the outlet pipe, and such as may pass through this pipe into the disinfection chamber are held there by the baffle wall and do not pass out with the effluent.

In applying the chlorine, no effort is made to adjust this to the amount of sewage, but the dose is set for sterilizing the effluent under conditions of maximum flow, it apparently being thought that the economy in attendance more than offsets any economy in chlorine that might be effected. The plant operates without any regular attendant, but is visited only occasionally to empty the basket screens and inspect the chlorine apparatus to see that it is operating and to renew the chlorine tank. The basket screens are raised to be emptied by a chain block and traveling crane. There are two square basket screens which rest in position in the receiving well, being supported by horizontal flanges fastened around their tops.

Chlorine is applied by a Wallace & Tiernan chlorinator, using dry chlorine feed and a composition sponge diffuser, which obviates the necessity of a water supply at the isolated point where the station was installed, and also prevents danger of interruption of the chlorine feed through freezing of the small water piping.

Mr. Piatt has also built similar plants at Tarboro and at Rocky Mount, N. C.

Germicidal Effect of Acid Mine Drainage*

Investigation of Lackawanna and Susquehanna rivers shows that acid reduces bacterial content more than 99 per cent. and prevents offensive decomposition of sewage reaching the river.

Investigations made by the Pennsylvania Department of Health show that the acid drainage from coal mines exerts considerable germicidal action upon sewage, and that streams heavily impregnated with acid mine drainage can receive, without creation of nuisance, far more untreated sewage than can normal or alkaline streams.

Lying above and in the coal-bearing strata are minerals containing iron and sulphur, the principal one being commonly known as iron pyrites. Ground water leaching through these deposits into mine openings, and hence in contact with air, causes a decomposition of the pyrites and the release of sulphuric acid.

Therefore, the drainage water either pumped or flowing by gravity from coal mines and the rain water leaching from culm banks is generally strongly acid in reaction.

During the recent coal strike the coal washeries were shut down so that very little coal dust (which gives the water a black, viscous appearance) was present in the streams, but the flow of acid mine drainage continued to be discharged. This condition afforded an excellent opportunity to make field investigations, because the presence of sewage solids could be observed in the streams.

*Paper before Pennsylvania Water Works Association by W. L. Stevenson, Assistant Chief Engineer, Pennsylvania Dept. of Health, slightly condensed.

TESTS OF GERMICIDAL EFFECTS

The Engineering Division of the Pennsylvania department of Health, therefore, made field and laboratory investigations during May and June, 1922, along the Lackawanna river and in the north branch of the Susquehanna river for a short distance below the mouth of the Lackawanna. This work was done under the general direction of C. A. Emerson, Jr., chief engineer; F. M. Daniels, chief of the Laboratory Section, and I. M. Glace, district engineer, by W. L. Long, chemist.

In making the laboratory investigations, sewage was added in various proportions to typical samples of acid mine water. The sewage used had a total count of six million bacteria per c. c., and gas formation was obtained from 1/1,000,000 c. c. samples. After only two hours contact with the acid mine water in ratios of one part of mine water and five parts of sewage, the total count was reduced to 32,300 per c. c. and gas formation to 1/1,000 c. c.

Two hours contact with ratio of one to one reduced the total number to 3,600 and gas formation to 1/100 c. c.

Not only was the total number of bacteria greatly reduced, but the flora surviving the disinfecting action were of a different character from those found in the undisinfected sewage. On the plates planted with the mixture of sewage and the higher concentrations of acid mine

water, most of the typical fecal lectose fermenters were absent. Gram positive cocci, spore forming bacilli and saphrophytic yeasts, molds and aerobic spreading forms were the only ones present.

In another test, sewage obtained from a public sewer which received a small quantity of acid mine drainage was added to a typical mine water in various proportions. In this case the total number of bacteria had been reduced by the small amount of acid mine drainage in the sewer to 15,000 per c. c., but gas formation was obtained in 1/10,000 c. c. portion of sewage.

In all ratios of mine drainage to sewage and with periods of contact of both one and three hours, the total numbers of bacteria were reduced and gas formation almost eliminated.

The sewage used in these experiments had a turbidity which remained practically unchanged for several days. Its hydrogen ion concentration was 6.4. The addition of one part of acid mine water to five parts of sewage changed the hydrogen ion content to 5.3 and caused a flocculation and sedimentation, of about 50% of the original turbidity. The addition of one part of acid mine drainage to three parts of sewage gave a hydrogen ion content of 4.4 and caused practically complete sedimentation of the suspended matter in one-half hour, producing a supernatant liquor of zero turbidity.

In a third set of experiments, finely ground anthracite coal was added to tap water and continued to remain in suspension. A series of concentrations were made varying from 0.1 gram to 10 grams of coal in 200 c. c. of water. The addition of an equal volume of acid mine water to all these samples caused precipitation of the fine coal within one hour. The presence of the coal had no effect upon the hydrogen ion concentration of the sample.

FIELD INVESTIGATIONS

In order that the laboratory studies might be confirmed by field investigations, a study was made of conditions in the Lackawanna and Susquehanna rivers. The Lackawanna river about fifteen miles from its source enters the coal regions as a reasonably clean and uncontaminated stream. Not far below this it receives two tributaries, both of which are impounded and used for public water supplies, so that during dry weather most of their flow reaches the Lackawanna in the form of sewage or waste water from coal washers.

It has a rather steep hydraulic gradient, this averaging 13.2 feet per mile from Pittston to Scranton, 20 feet per mile for the next fifteen miles, increasing to 45 feet per mile for the next thirteen miles. Consequently, sewage solids and fine coal are maintained in suspension.

The water shed of the Lackawanna contains about 130 collieries and washeries, but no other stream-polluting industries of much moment. The population of the municipalities on the shed is about 320,000. It is estimated that about 37,000,000 gallons of water is used per day for domestic and manufacturing purposes and about 13,000,000 in the coal industries.

The amount of acidity reaching the Lackawanna from mine drainage and leaching from culm banks is not known, but it is estimated that 23,000,000 gallons of drainage was pumped from the mines per nine-hour day in 1913. A knowledge of the acid and iron content of typical mine drainage leads to the estimate that the river above Pittston contains about one part of mine drainage to six and two-thirds parts of stream flow.

Examination of sewer outlets showed that, in practically all cases where these are submerged beneath the water, the sewage cannot be detected by either sight or smell at any time of the year; the only nuisance being where, at time of low stream flow, the sewer discharged above the water line.

On Sept. 10th, 1922, however, when the mines were not in operation, the sewage of Scranton and other towns up-stream was visibly evident in the water of the river. At sewer outlets and where the sewage was discharged on the bank the typical sewage odor was noted, but at no place was there any offensive sewage odor from the stream itself. At this time the flow of the stream was only about 0.4 second-foot of diluting water per 1,000 persons contributing sewage to the stream, which would be considered totally inadequate for preventing nuisance in the case of ordinary diluting water.

The Susquehanna river is a much larger stream than the Lackawanna, draining an agricultural country and shows little evidence of pollution. For some distance after the confluence of these two streams, the black, turbid water of the Lackawanna and the clear water of the Susquehanna follow opposite banks of the river, but gradually they intermingle. Samples of water from the two rivers were examined for dissolved oxygen content, and the germicidal action of the acid mine drainage was clearly shown by the very slight decomposition of the organic matter in the Lackawanna river water during the incubation period. The biochemical oxygen demand of the two rivers was practically the same, although one was comparatively pure and the other heavily polluted with sewage. Samples of the Lackawanna river water that were kept twenty hours in the icebox were nearly sterile, although others taken at the same time and plated promptly showed an average of about 2,500 c. c. after forty-eight hours on agar at 37.5°.

The sewage of Hazelton is discharged into a small stream composed almost wholly of acid mine drainage. Samples of this stream, taken at a point such distance below the sewer outlet that there had been about forty minutes contact of sewage with acid stream water, showed a total of 1,490 bacteria per c. c., and gas formation was obtained with no dilution higher than 0.1; while samples allowed to stand for eighteen hours showed only 260 bacteria and gas in one c. c. As further evidence of the effect of the acid in the river, even in hot weather no nuisance from odors is reported from this sewage-laden stream.

Building Brooklyn Bridge Pier

Nine hundred and thirty-three reinforced concrete piles cast in double tiers, cured, waterproofed and transported without any cracks. Reinforcement bars bent by hand. Economical method of assembling; forms concreted from floating plant. Piles driven with steam hammer, twin hydraulic jets and special follower.

At the foot of Roosevelt street, New York, a pier is being built with reinforced concrete floor or deck, supported on reinforced concrete piles and projecting into the East River, this being the first time that this type of construction has been used in New York. In plan, it is an irregular T-shape with a stem 127 feet wide that is parallel to the shore line and 203 feet long on the river side. The other portions, perpendicular to the shore line, have an aggregate length of 550 feet and width of about 90 feet at the shore end and 40 feet at the river end. The structure contains 933 piles which with the deck were built by the G. B. Spearin Company, New York, for a contract price of about $465,000. The stem of the pier forms a platform entirely enclosing the 130x65-foot pier of the main tower at the west end of the famous Brooklyn Bridge.

The piles, 16 inches square and from 46 to 80 feet long, with pointed lower ends and chamfered corners, are reinforced with four 1¼-inch round bars in each pile and weigh from 6½ to 11½ tons each.

The piles were cast on the contractor's pier at Hunts Point, where space was very limited, and concreting, waterproofing and storing were simultaneously carried on on a platform that was Z-shape in plan with different sections respectively about 300 feet, 280 feet and 460 feet long and all of them about 57 feet wide. Forms for groups of piles of the same lengths were set up on the floor and open transverse spaces 3 feet wide were left between the different groups to provide for the easy disposal of refuse. The middle section of the Z-shape area was reserved for storage and the 460-foot section was used for waterproofing.

The lower tier of forms was made with vertical panels of 2x4-inch planks, built parallel to each other and 18 inches apart on centres, the lower edges of the planks being secured to wooden sills nailed to the floor. Adjacent pairs of planks were braced together by horizontal frames 16 feet long and 16 inches wide over all, which had two side strips and three transverse strips and were supported on cleats nailed to 2x4-inch vertical posts nailed to the form planks 10 feet apart and projecting several inches above them to receive 2x4-inch transverse struts that spaced all of the forms in the set. This arrangement left every alternate opening between the form planks clear to receive the concrete. After the form planks and braces had been removed and the piles painted with petroleum oil, of which about 12 barrels were required, the spaces between the piles were concreted, the vertical sides of the first set of piles serving as forms for the second set. The lower corners of the piles were chamfered by triangular filler blocks placed on the floor; the upper corners were chamfered by a special trowel provided with a triangular rib that was run along the side of the form and made a smooth furrow in the wet concrete.

Pile Reinforcement.—The reinforcement, which

FLOATING, MIXING AND SPOUTING EQUIPMENT FOR CONCRETING PILES.

for the longest piles weighed about 2,000 pounds, was uniform for all piles and consisted of one 1¼-inch bar in each corner of the pile. These bars were received in lengths of 17 to 50 feet, and were over-lapped 5 feet and wrapped with wire at each splice. They were held in position by ¼-inch round wire hoops, 9 inches apart on centres, to which they were securely wired at intersections. When done by the usual method with short pieces of wire, cut to length, one man could make about 250 fastenings in an 8-hour shift. To expedite the work, the superintendent devised a method of reeling the wire from the coils in which it was received to a home-made, hand-operated reel that transferred it to convenient spindles. One end of the wire on the spindle was wound tightly around the intersection of the reinforcement bar and wound, twisted and the wire carried without cutting to the next intersection, wound, twisted and the operation repeated on the next joint, and so on, continuously, thus saving a considerable amount of time and labor and enabling one man to make about 600 connections in one shift, 500 being required for the longest pile.

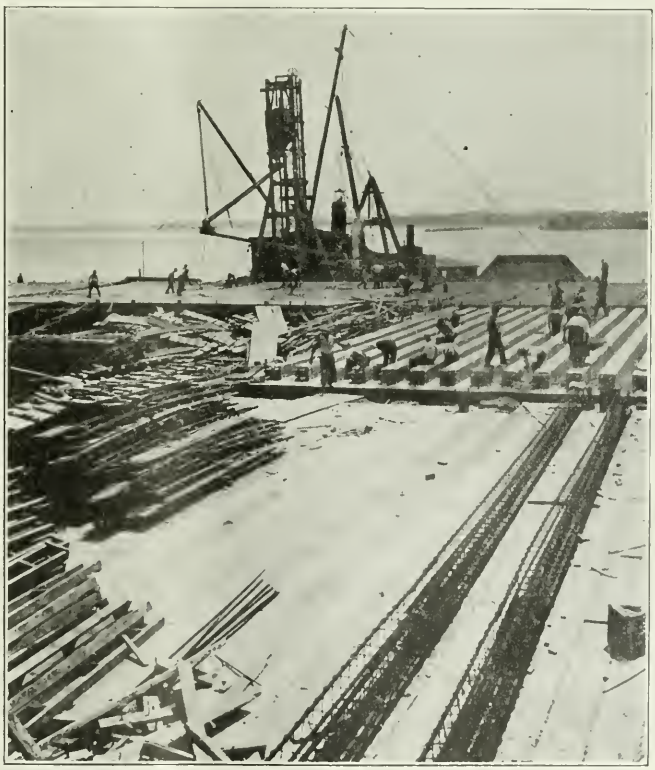
Slab Reinforcement.—The slab reinforcement bars were easily bent by hand with a special tool called a "hickey," which consisted of a short, heavy vertical bar with a long hook pivoted to it and a gas pipe handle several feet in length. The reinforcement bar was placed flat on the deck and the foot of the hickey set on the bending point with the hook engaging it a few inches beyond so that by revolving the extension handle in a vertical plane the bar was easily bent around the foot of the hickey. The men became so expert that two of them working together could make 3,600 single bends on a 1-inch bar in 8 hours, and after some practice did the work accurately, without templates, simply judging the bend by the eye.

A gang of about 40 men were kept busy assembling the reinforcement. The finished units were lifted by hand with carrying hooks and placed in the forms, where they were supported the proper distance above the bottom by Z-shape hooks engaging the upper bars and fastened to 2x4-inch horizontal transverse pieces resting on the upper edge of the form planks. After the concrete was poured, the hooks were detached and used again in the next set of forms.

Pile Concreting—The pile forms were filled with concrete mixed in a 90x34-feet scow, 8 feet deep, moored alongside the casting platform. The scow was equipped with a 1-yard Ransome mixer, a Chain-Belt conveyor delivering cement to the mixing platform, and a 74-foot derrick boom supplying aggregate to the 12-yard elevated stone storage and the 12-yard sand storage bin. The mixer delivered concrete to the hoisting bucket in a tower 50 feet high, that was provided with 70-foot and 40-foot booms carrying the steel chutes for spouting the concrete to position. The concrete plant was operated by 15 men on the scow.

When the first tier of piles were three or four days old, 4x10-inch transverse pieces were set on them and supported 16x54-inch wooden panels forming the bottoms of the forms for a second tier of piles which were made and poured in the manner already described. The first piles were cast July 13th and 554 piles were made in the first lot and 379 piles in the second lot, which was finished March 1. About 4,000 yards of concrete and 670 tons of reinforcement steel were required for these piles.

After the piles had cured sufficiently for safe handling, a single course of them, with 4 inches



CONCRETING SECOND TIER OF PILES. ALTERNATE PILES STRIPPED.

clearance, was laid on four or five lines of transverse 12x12-inch skids about 16 feet apart, the ends of adjacent piles being staggered from 10 to 12 feet to make them conveniently accessible for the application of the waterproofing. Then 12x24-inch skids were laid across the first tier of piles and a second tier of piles similarly placed on them and waterproofed, and so on until all of the piles had been treated and remained in compact storage until removed for driving.

The specifications require that the piles, which were made with 1-1-2 concrete, using ½-inch to 1-inch stone, should be seasoned thirty days before moving and 15 days longer after waterproofing before being driven. They were required to be handled by attachments made at 1/5 of their length from each end, and supported in storage on three or more lines of skids. The upper ends of the piles are required to be waterproofed down to an elevation 2 feet below waterline, thus providing for a length of 9 feet on vertical piles and 11 feet on batter piles with a protection consisting of metal mesh and special mortar.

First there were applied three layers of felt and two of fabric saturated and cemented together with hot coal-tar pitch. The felt was required to weigh 14 pounds per 100 square feet and the pitch was mopped in coats 1/16 inch thick, the felt and fabric alternating and well rubbed and pressed for adhesion. The inner layer of fabric was 3x8-inch diamond mesh expanded metal weighing 27 pounds per 100 square feet, and the outer layer was 4x2-inch triangular mesh fabric weighing 31 pounds per 100 square feet, both layers being well wired on and the outer one being covered with ½ inch of gunite.

Pile Driving—The piles were driven in water from 18 to 35 feet deep at low tide and penetrated through 4 to 10 feet of soft mud to sand and hard clay, encountering considerable obstructions from the ruins of old stone, timbers and rip rap for old piers and bulkheads. They were spotted in the usual manner by alignment with shore ranges and by longitudinal measurements.

FORMS READY TO RECEIVE FIRST SET OF ALTERNATE PILES

They were driven with a regular pile driver scow having an 86-foot tower and equipped with a 2-drum Lambert hoisting engine and attended by a pump scow delivering 200 pounds working pressure through two 3-inch hose lines each terminating with a 1½-inch nozzle.

The derrick boat delivered piles in sets of about twenty to the pile driver that handled them with a two-part tackle, swinging them to vertical position in front of the leads, where a second line was attached to them and the tackle released. About five minutes was required to pick the pile up and place it in position for driving, where it ordinarily sank about 10 feet into the soft mud under its own weight. An hydraulic jet was churned up and down on each side of the pile, handled by a skeleton engine on the pile driver scow, that settled the pile 10 to 20 feet in from 10 to 20 minutes. The jetting was then stopped and the pile was driven 2 feet farther in from 5 to 15 minutes by a 66,000-pound McKeirnan-Terry hammer operated by steam at 150 pounds pressure. The best day's work was twenty-five vertical piles driven with a special follower that permitted such accuracy that the tops did not require to be cut off.

The follower consisted of a five-foot length of extra heavy 8-inch steel pipe with an oak bearing piece fitted into the lower end and a heavy oak cap doweled into the upper end. Between the cap and bearing piece the interior of the pipe was filled with 1-2-4 concrete reinforced by four vertical ¾-inch rods. A pair of oak fillers were through bolted to opposite sides of the pipe, their outer faces engaging the pile driver leads. The oak foot block cushioned the blows on the concrete piles without reducing the efficiency of impact and the oak cap, 18 inches high, received most of the wear and, like the foot block, was renewed about once a week, while the body of the follower lasted indefinitely. This arrangement was found to be advantageous for the hammer and for the piles and very economical.

Besides the vertical bearing piles, there were also driven 109 batter piles from 58 to 80 feet in length which, during driving, were supported at the required angle by two slings and by bearing on a roller supported by two adjacent piles. These were driven entirely by the use of the two water jets operated on top of the pile and it required ordinarily about one hour to drive each pile.

The work was executed by a maximum force of about 100 men, under the direction of Russell D. Love, superintendent for the contractor, who devised the pile hooks, connection wiring, pile forms, followers and other details of operation. Major Henry Asserson, division engineer, is engineer in charge representing the New York City Dock Department. Joseph De Temple is chief inspector for the Dock Department.

PUBLIC WORKS

Published Monthly
at 243 W. 39th St., New York, N. Y.

S. W. HUME, President J. T. MORRIS, Treasurer

Subscription Rates
United States and Possessions, Mexico and Cuba $3.00 year
All other countries 4.00 year

Change of Address
Subscribers are requested to notify us promptly of change of address, giving both old and new addresses.

Telephone (New York): Pennsylvania 4290
Western Office: Monadnock Block, Chicago

A. PRESCOTT FOLWELL, Editor

CONTENTS

GARBAGE COLLECTION AND DISPOSAL IN RICHMOND, IND. Illustrated. By D. B. Davis 251

War Department Gives Nevada Draglines 253

ILLINOIS EXPERIMENTAL HIGHWAY TESTS. By Chas. Carroll Brown 253

LAYING VERTICAL FIBRE BRICK. Illustrated. By Robert H. McKinley 255

Public Stairways 256
Road Oiling in Wyoming 257
Use of Base Before It Sets 257
Questionnaires for Bidders 257

ECONOMICAL CONTROL OF CHEMICAL DOSAGE IN FILTER PLANTS. By R. A. Maddock 258

Oil Pollution of Waters 260
Sea Water and Wells 260
Hail Causes a Canal Break 260

COST OF SEWER JOINTS IN WET TRENCHES. By M. H. Walser 261

ACTIVATED SLUDGE FOR PACKING HOUSE WASTE AT MASON CITY 262

Land Disposal of Liquid Sludge 263
Dangerous Gas in Sewage Filters 263
Chlorinating Sewage at Selma 263

GERMICIDAL EFFECT OF ACID MINE DRAINAGE 264

BUILDING BROOKLYN BRIDGE DOCK. Illustrated 266

EDITORIAL NOTES

Profit and Loss in Refuse.
Civil Service Examinations 270
Instruction for Water and Filter Operators 270

STREET CLEANING AND REFUSE DISPOSAL DATA 270

TABLES: Street Cleaning 272
Refuse Collection 281

SOME REFUSE INCINERATORS 285

Profit and Loss in Refuse

Two or three years ago turning garbage into live hogs, or into grease and tankage, was found profitable by a number of cities. Today it is not. What it will be next year we do not venture to predict, but it does not seem probable that those products of garbage utilization will ever again reach war prices.

As to hog raising, we find that a number of contractors who had agreed to pay cities for garbage to be used for feed have "gone broke," while most municipal hog farms have lost money or been abandoned. Even more serious has been the condition of the reduction plants. For a number of months they could find no purchasers of one of their products—tankage—at any price, while the price of garbage grease fell to a fraction of that obtained during the war. Of course, the cost of labor and supplies fell also, but not to the same extent, and the interest and depreciation on the cost of the plant, which was a very large item, remained undiminished. Probably the only plan now practicable for recovering anything from garbage, or even for being able to give it away, is to sell it to farmers who raise pigs incidentally. New England municipalities would appear, from the answers to the questionnaires recently sent out by this journal, to be especially successful in this.

These methods play no part in disposing of rubbish, and for this there would seem to be only two alternatives—dumping on waste land, or burning the combustible matter and using the ashes from this and the incombustible matter for fill. In many cases grading with incombustible matter adds greatly to the value of low, swampy or submerged land, and where there is such a possibility it furnishes the most reliable method of profiting by refuse disposal.

Another possibility of profit is the use of combustible refuse as fuel for power production. As high pork favored pig farming, high and scarce fuel would seem to favor utilization of heat from incineration, with less risk of sudden collape of the revenue-favoring conditions. If not used in this way, the heat from combustible refuse can be utilized for destroying that too moist to burn without dry fuel, such as garbage, dead animals and night soil, and in doing this producing a profit in that it takes the place of purchased fuel that would otherwise be used.

Garbage can be disposed of by burying or dumping, by utilizing, or by burning. Burying requires more land than is available for most communities, and is really expensive if properly carried out. Dumping as generally done creates an indefensible nuisance, and is seldom to be tolerated. The choice between utilization and burning is largely one of expense. Under present conditions probably no community is obtaining a profit from its reduction plant, and the question is whether the loss of operating it is greater than the cost of burning the garbage. Moreover, the cost of a reduction plant is so great that no city of less than 100,000 population could make a profit from it under any condition.

Of the permissible methods of disposal available

incineration with the aid of combustible rubbish would seem to combine the least net cost with the most sanitary and otherwise acceptable results. A careful reading and weighing of the several hundred replies to our questionnaire, which are given in this issue and the January one, would seem to confirm this opinion.

Civil Service Examinations

The following examinations are to be held by the U. S. Civil Service Commission:

Assistant Engineer (Irrigation and Drainage), $1,920 a year. Receipt of applications closes December 26.

Electrical Engineer, $4,000 to $6,000. Receipt of applications closes December 26.

Topographic and Subsurface Draftsman, Grade A, $6.80 per day. Receipt of applications closes December 26.

Computer, Coast and Geodetic Survey, $1,640 to $2,240. Examinations will be held March 7 and 8.

Instruction for Water and Filter Operators

A short course for water and filter plant operators, the fifth, will be held during the week beginning January 15th at Municipal Building, Dallas, Texas, under the auspices of the Dallas City Health Department, with the Texas State Board of Health and the Texas Water Works Association co-operating.

Following general lectures on Monday, Tuesday will be "Filter Plant Day," when the classes will be held at the new White Rock Filter Plant, as will also the classes on Friday, which will be "Filter Plant and Inspection Day." Among the lecturers will be Major J. B. Hawley of Dallas, Lewis I. Birdsall of Chicago, A. F. Allen of the U. S. Public Health Service, R. E. McDonnell of Kansas City and a number of chemists, bacteriologists, engineers and public health experts of Dallas and other Texas cities.

Street Cleaning and Refuse Disposal Data

Information Concerning Appliances and Methods Used by About Two Hundred and Fifty Municipalities, as Reported by Their Officials, in Cleaning Streets, Collecting Refuse of Various Kinds, and Disposing of It.

In the tables given in the following pages will be found information, given directly by the officials of nearly two hundred and fifty municipalities, showing the kinds and numbers of appliances used by each in cleaning the streets and collecting all kinds of refuse; the general plan under which each class of refuse is collected and the cost to the municipality or householders, and the satisfactoriness of the collection. Also data are given concerning the disposal of the refuse, the kind of plant used, if any, the cost and satisfactoriness of operation.

Many of the replies to our questionnaire gave more abundant information than it was practicable to tabulate, and the more important features are given in the following paragraphs, in which will be found some very interesting facts, figures and opinions.

CLASSIFICATION OF REFUSE

Classification of rubbish varies considerably in different sections of the country, which is unfortunate for a comparison of methods similar to that which we are undertaking this month. However, we have endeavored to change the classifications used by the several informants to correspond to those that are used in practically all literature on the subject, namely, garbage, including all food refuse, ashes, and rubbish, which includes all other refuse from residences.

In Havre, Montana, the city ordinance defines garbage as "all refuse, animal and vegetable matter, office, house and store sweepings, ashes, waste paper, and dead dogs, cats and fowls."

Garbage is defined by the city of Seattle to include paper, ashes, vegetable and animal refuse, and all waste material of every kind and description.

In several of the Western states garbage is used to include rubbish, the term "dry garbage" apparently being used for rubbish and "wet garbage" for garbage proper. One case which seems to be exceptional is an Indiana city which uses the word "slops" for describing garbage, while the word "garbage" covers "all except kitchen refuse." It certainly seems desirable that all municipalities should adopt the terminology which is employed by Eastern cities, and, we believe, by all writers on the subject.

REFUSE COLLECTION

OAKLAND, CALIFORNIA

In Oakland, California, refuse is collected by an organization of Italians called the "Alameda County Scavengers' Association," under an arrangement with the city for charging fifty cents per month for one collection per week for an average family of five, this including ashes, tin cans and garbage. The rubbish is dumped.

RICHMOND, CALIFORNIA

Richmond, California, has a contract running for ten years by which the rubbish is collected by scavengers who pay the city for the privilege fifty dollars for the first five years and one hundred dollars per year thereafter. The scavenger is to collect all garbage and rubbish on the basis of stated fees, which the city council may increase if it thinks desirable, and must deposit it

at a point or points designated by council and must burn all inflammable matter, furnishing the oil necessary for this, and keep the dump in a sanitary condition. Collections must be made at least once a week from residences and three times a week from other places. The charges permitted are from 35 cents a month to 50 cents for residences, depending on the haul, with 35 cents per month for each additional collection.

BRIDGEPORT, CONNECTICUT

In Bridgeport, Connecticut, the collection of garbage and ashes and disposal of the latter are performed by the Division of Waste Collection of the Department of Health, there being a superintendent of ash collection, superintendent of garbage collection and superintendent of municipal reduction plant. Ashes are collected weekly by horse-drawn Lee trailers, which are then carried by a Packard truck to a convenient dump. During the year 1921-22 the Division collected 16,255 loads of ashes at a cost of about $2.79 per load. Occasional weighings of loads at different times gave an average weight of approximately three tons.

Garbage is collected in the same way. However, in outlying sections where the houses are widely separated a small, quick-moving motor truck is used, which collects the garbage in large cans and either dumps these cans into the nearest trailer in that part of the city or takes the collection immediately to the reduction plant. This reduction plant is situated directly within the city. During the years 1921-22, 13,807 tons of garbage were collected at a cost of $3.41 per ton and were treated at the reduction plant at a net expenditure of $71,790.

HARTFORD, CONNECTICUT

In Hartford, Connecticut, ashes and rubbish are collected mixed by the Street Department, daily in the central part of the city and once a week elsewhere. Receptacles are taken from the rear yard to the curb by employees using light two-wheel hand freight trucks and are returned to the rear when empty. The rubbish is emptied in 4½-cubic yard Watson bottom-dump wagons and is hauled an average distance of one mile to twelve different fills, where low ground is being brought up to grade.

Garbage is also collected by the Street Department, but three-quarters of it is taken by about seventy farmers and used for feeding pigs, each farmer being given a license and assigned a particular route. Farmers having specially good routes are paid nothing, but about fifty are given a small amount of money at the end of each six months, from which fines are deducted for complaints, leaky wagons, lack of covers, etc. Collections are made daily in the business center and two or three times a week throughout the remainder of the city. The garbage collected by the city employees is sold to pig owners, except that a small amount may have to be buried at different times "when there is no market for the entire amount."

From the population of 140,000, occupying an area of 17½ square miles, the city collected ashes and rubbish during the last fiscal year amounting to 286,695 cubic yards at a cost, including repairs and additions to equipment, of 66¾ cents per cubic yard. The garbage collected by the licensed collectors amounted to 18,075 cubic yards, which cost the city 33 1-3 cents per cubic yard. Collections made by the department employees amounted to 5,888 cubic yards and cost $3,394 per cubic yard. Wages of regular employees were $4.50 per 8-hour day, and $9.50 was paid per 2-horse team and driver, the city furnishing the wagons only.

For fifteen or more years prior to June, 1913, ashes, rubbish and garbage were collected under a series of five-year contracts. This method became so unsatisfactory that the work was taken over at the expiration of the last five-year contract on the date mentioned and the municipal collection has been satisfactory to the public.

NO SUPERVISION

An objectionable feature of no municipal supervision over garbage collection is found in a Connecticut borough of 10,500 population. Here farmers collect about 10 per cent of the garbage, but most of the citizens dispose of the garbage in stoves or gardens and the borough engineer reports that "the gardens are filled with garbage and it is impossible to bury same during the winter."

POCATELLO, IDAHO

In Pocatello, Idaho, garbage is collected by two contractors, one from hotels and restaurants without cost to the city, the other from residences, for which he receives $546 a month. The first contractor uses the garbage for feeding, while the second dumps the garbage into a deep ravine approximately a mile from the city limits, where it is burned and covered by an attendant who receives $30 a month. Ashes are collected by the city and when clean are used for fills in streets and alleys, those containing rubbish or garbage being dumped in the ravine.

This gives an average cost during each summer month of $546 to contractor and $30 to dump attendant, a total for the seven summer months of $4,032. During the five winter months there is an additional cost of $130 a month for ash collection, or a total of $3,530 for the five months. For the summer collection of garbage there are used three teams, averaging 2¼ trips per day and carrying 1.3 tons per trip for twenty-five days a month. This gives 220 tons collected and disposed of at an average cost of $2.60 per ton. During the winter the three teams average 1.8 trips per day, carrying 1.3 tons per trip, 175 tons being collected and disposed of at an average cost of $3.30 per ton. One team, averaging 4.5 trips per day and carrying two tons per trip, removes an average of 225 tons per month of clean ashes and cinders from schools and business houses at an average cost of 60 cents per ton. Four hundred tons of general ashes average $1.75 per ton.

EVANSTON, ILLINOIS

In Evanston, Illinois, the householder has the choice of two systems of garbage, collection;

(Continued on page 284)

STREET CLEANING

City	Miles of Street Cleaned: Daily	1 to 3 Times a Week	Less Than Once a Week	Equipment Owned by City	Equipment Preferred for Use on Each Kind of Pavement: Kind of Pavement	Equipment Preferred	
Alabama:							
Mobile	24	9	none	27 hand brooms, 8 can carriers, 85 street cans, 1 sprinkling wagon (horse), 12 dirt carts	.....	.....	
Opelika	..	..	..	4 hand brooms, 1 machine broom (horse), 1 sprinkling wagon, 2 dirt carts	.....	.....	
Talladega	..	1½	..	2 hand scrapers, 1 can carrier, 20 street cans, 1 sprinkling wagon (horse)	Asphalt	Hand scraper (cheapest to operate)	
Arizona:							
Clifton	7	..	..	2 garbage trucks, 1 sprinkling wagon (motor)	Gravel	Garbage trucks pick up trash	
Miami	1	..	..	6 hand brooms, 80 street cans, 1 sprinkling wagon (horse), 2 dirt wagons	.....	.....	
Tucson	5	4	none	9 hand brooms, 7 can carriers, 4 sprinkling wagons (horse), 5 dirt wagons, 1 fire hose	Bituminous	Hand sweeping most economical	
California:							
Marysville	..	..	..	36 hand brooms, 1 pick-up sweeper, 10 street cans, 3 sprinkling wagons (horse), 3 dirt wagons	.....	.....	
Monrovia	3	..	..	12 hand brooms, 2 hand scrapers, 1 machine broom (horse), 1 can carrier	.....	.....	
Ontario	..	1	12	12 hand brooms, 1 machine broom (horse), 8 street cans, 1 sprinkling wagon (horse), 1 dirt wagon	.....	.....	
Petaluma	1½	..	..	24 hand brooms, 4 hand scapers, 1 machine broom (horse), 2 can carriers, 24 street cans, 1 dump wagon	Macadam Business dist.	Hand brooms White wings	
San Bernardino	2	..	5	12 hand brooms, 1 machine broom (horse), 3 can carriers, 6 street cans, 3 sprinkling wagons (horse), 5 dirt wagons, 3 dirt carts	.....	.....	
San Francisco	..	..	..	140 hand brooms and scrapers, 10 h.d. machine brooms, 4 motor pickup sweepers, 1,500 street cans, 11 h.d. flushing machines, 1 motor flushing machine, 7 h.d. sprinkling wagons, 12 dirt wagons and steel covers, 50 dirt wagons (rented),	.....	.....	
San Gabriel	..	..	20	6 hand brooms, 1 auto truck	.....	.....	
Santa Ana	10	1	..	24 hand brooms, 1 h. d. machine broom, 1 motor machine broom, 1 can carrier, 3 h. d. sprinkling wagons, 2 dirt wagons	.....	.....	
Santa Barbara	2	56	10	6 hand brooms, 2 machine brooms (motor), 4 pickup sweepers, 2 can carriers, 2 sprinkling wagons (horse), 2 sprinkling wagons (motor), 3 dirt wagons	Macadam and Bituminous Concrete Business dist.	Brooms Flushing White wings	
So. Pasadena	2	..	1	12 hand brooms, 4 street cans, 2 sprinkling wagons (horse), 1 dirt wagon	.....	.....	
Colorado:							
Denver	70	20	10	150 hand brooms and scrapers, 12 machine brooms (horse), 10 machine brooms and 4 pick-up sweepers pulled by motor trucks, 1 Elgin sweeper, 4 pick-up sweepers (horse), 3 gutter sweeping machines, 500 street cans, 10 flushing machines (horse), 2 flushing machines (motor), 80 sprinkling wagons (horse), 12 sprinkling wagons (motor), 45 dirt wagons, 10 snow blade machines, 24 white wing push carts	Brick and Bituminous Concrete, stone block, wood block Macadam	Flushers Sweepers—Use mostly flushers in summer, sweepers in winter Hand brooms	
Fort Collins	10	22	..	12 hand brooms, 18 street cans, 1 flushing machine (motor), 2 sprinkling wagons (horse), 1 dirt cart, 1 snow plow	Concrete Residence dist.	Flusher Sprinkler	
Greeley	..	..	..	2 doz. hand brooms, 6 hand scrapers, 2 sprinkling wagons (horse drawn), 2 sprinkling wagons (motor driven), 4 snow plows	.....	.....	
Connecticut:							
Hartford	22	none	120	380 hand brooms, 70 hand sweepers, 1 h. d. machine broom, 6 hand pickup sweepers, 312 cans, 4 h. d. flushing machines, 2 motor flushing machines, 25 h. d. sprinkling wagons, 1 motor sprinkling wagon, 2 squeegees, 21 dirt carts, 12 snow plows	.....	.....	
Middletown	3	5	16	48 hand brooms, 24 hand scrapers, 2 machine brooms (horse drawn), 8 white wing carriers, 1 flushing machine (horse drawn), 1 sprinkling wagon (motor driven), 2 wagons collect street dirt, 1 cart for same, 2 snow plows	Bituminous Brick Stone, wood block, Macadam Res. dist.	Flusher Flusher Broom	Less complaint

New Britain	6	..	30	25 hand scrapers, 1 machine broom (h. d.), 12 white wing carriers, 2 flush machines (h. d.), 4 snow plows	.....	.....	
New Haven	80	25	50	20 gro. hand brooms, 100 hand scrapers, 2 machine brooms (horse drawn), 85 white wing can carriers, 1 flushing machine (h. d.) 3 flushing machines (motor driven), 10 sprinkling wagons (horse drawn), 1 sprinkling wagon (motor driven), 10 wagons for collecting street dirt, 4 carts for collecting street dirt, 2 snow plows	Bituminous Concrete Brick, stone, wood, macadam Bus. dist. Res. dist.	Brooms Flusher Brooms Flusher Brooms	Too much water ruins bituminous pavement. Water on wood block is dangerous
New London	3¼	2.3	..	12 hand brooms, 1 h. d. machine broom, 12 can carriers, 24 cans, 1 h. d. sprinkling wagon, 2 snow plows	.....	.....	
Willimantic	..	..	..	2 white wing carriers, 1 sprinkling wagon, 3 trucks collect street dirt, 3 snow plows	Stone block, macadam Bus. dist.	White wings	
Dist. of Col.:							
Washington	225	40	110	1,000 hand brooms, 300 hand scrapers, 17 machine brooms (h. d.), 2 machine brooms (motor driven), 1 pick-up sweeper, 200 can carriers, 5 flush machines (h. d.), 2 flush machines (motor driven), 26 sprinkling wagons (h. d.), 15 squeegees, 31 wagons collect street dirt, 45 carts collect street dirt, 10 snow plows, 2 motor trucks	Bituminous Bus. dist. Concrete, wood block Brick, stone, block Macadam Res. dist.	Flushers—In Bus. dist. owing to vehicles on streets Motor brooms—Distant streets Horse brooms—Close to stables Hand brooms Squeegees—Close to stables	
Florida:							
Sanford	½	4	6	50 hand brooms, 10 hand scrapers, 1 machine broom (horse drawn), 2 can carriers, 1 sprinkling wagon (h. d.), 5 dirt wagons, 1 night soil wagon	.....	.....	
Georgia:							
Albany	12	24	4	48 hand brooms, 24 hand scrapers, 6 pickup sweepers, 20 cans, 1 h. d. sprinkling wagon, 4 dirt wagons, 6 dirt carts	Brick, wood block, macadam Bituminous, stone block	Motor broom Flushing. Expect to purchase motor broom and flusher	
La Grange	6	..	..	12 hand brooms, 1 machine broom (motor driven), 1 flushing machine (motor driven)	Concrete and brick	Flusher	
Rome	4	8	..	60 hand brooms, 2 machine brooms (h. d.), 12 can carriers, 1 sprinkling wagon (horse drawn), 1 sprinkling wagon (motor driven), 2 dirt wagons	Bituminous, concrete, brick, stone, wood Macadam	Flusher Flusher Sprinkler	
Idaho:							
Caldwell	1⅜	..	..	1 hand broom, 1 pickup sweeper, 1 flush machine (motor driven), 2 sprinkling wagons (h. d.), 1 sprinkling wagon (motor driven), 2 dirt wagons	.....	.....	
Pocatello	1.9	8.6	15	24 hand brooms, 1 machine broom (motor driven), 3 can carriers, 1 flush machine (h. d), 2 flush machines (motor driven), 1 sprinkling wagon (h. d.), 2 dirt wagons, 3 snow plows	Bituminous Concrete Bus. dist. Res. dist.	Flushing—Appearance, low cost, combination flush and sprinkling most useful	
Illinois:							
Blue Island	..	..	..	36 hand brooms, 1 machine broom (h. d.), 1 sprinkling wagon (h. d.), 4 dirt wagons, 5 snow plows	Bituminous, Macadam Bus. & Res. dist.	Hand brooms	Horse drawn would tear up pavement
Canton	..	..	..	12 hand brooms, 1 machine broom (h. d.), 4 can carriers, 1 sprinkling wagon (h. d), 3 dirt wagons, 2 snow plows	Brick, concrete, stone— Concrete, brick Bus. & Res. dist.	Machine brooms Hand brooms	Machine brooms Hand brooms more accessible at curb because of parking cars
Chicago	400	300	500	2,880 hand brooms, 1,070 hand scrapers, 5 gutter brooms, 11 pickup sweepers, 800 can carriers, 70 scrapped flush machines, 18 flush machines (motor driven), 25 snow plows	Macadam	Hand brooms—more economical	
Decatur	2	5	2	24 hand brooms, 12 hand scrapers, 3 h. d. flushing machines, 1 sprinkling wagon (h. d.), 5 dirt wagons, 2 dirt trucks, 5 snow plows	Bit. conc., res. dist. Brick, bus. dist.	Flusher Sweeper	Less expense to operate
Galesburg	..	..	..	24 hand brooms, 3 hand scrapers, 2 h. d. machine brooms, 4 can carriers, 12 cans, 1 h. d. sprinkling wagon, 3 dirt wagons, 4 snow plows	.....	.....	
Metropolis	..	..	..	1 sprinkling wagon (h. d.)	.....	.....	
Monmouth	..	..	..	36 hand brooms, 2 hand scrapers, 1 dirt wagon	.....	.....	
Oak Park	1	2	85	11 hand brooms, 1 pickup sweeper, 2 can carriers, 4 dirt wagons, 1 motor, 1 steel and 20 wooden snow plows	Bit., conc., brick, macadam, bus.-res. dist.	Hand brooms	
Indiana:							
Anderson	10	2	..	36 hand brooms, 2 machine brooms (h. d.), 1 h. d. flushing machine, 2 h. d. sprinkling wagons, 4 dirt wagons, 4 snow plows	.....	.....	
Bedford	1	4	60	12 hand brooms, 1 h. d. sprinkling wagon, 3 dirt trucks	.....	.....	
Brazil	2	5	10	16 hand brooms, 1 h. d. machine broom, 2 dirt wagons, 2 snow plows	.....	.....	

STREET CLEANING—(Continued)

City	Miles of Street Cleaned: Daily	1 to 3 Times a Week	Less Than Once a Week	Equipment Owned by City	Equipment Preferred for Use on Each Kind of Pavement: Kind of Pavement	Equipment Preferred
Indiana (Continued):						
Columbus	..	..	..	18 hand brooms, 5 hand scrapers, 1 h. d. machine broom, 1 h. d. flushing machine, 1 h. d. sprinkling wagon, 2 dirt wagons	.....	.....
Indianapolis	120	200	210	720 hand brooms, 250 hand scrapers, 20 h. d. machine brooms, 100 white wing carts, 200 cans, 4 motor flushing machines, 8 h. d. sprinkling wagons, 8 squeegees (not used), 40 dirt wagons, 50 dirt carts, 4 snow plows	Bit., conc., wood Macadam	Flushers preferred as more efficient and sanitary Brooms
Lebanon	1	2	..	1 machine broom (h. d.)	.....	.....
Mishawaka	..	..	..	12 hand brooms, 6 hand scrapers, 2 h. d. machine brooms, 2 can carriers, 5 dirt wagons, 16 snow plows	.....	.....
Peru	1	6	..	36 hand brooms, 1 machine broom (h. d.), 1 pickup sweeper, 1 vacuum cleaner, 1 h. d. flushing machine, 1 dirt wagon, 12 snow plows	All kinds	Sweeping, to prevent flushing dirt into sewers
Richmond	..	..	..	2 h. d. machine brooms, 1 h. d. sprinkling wagon	.....	.....
Shelbyville	..	2	..	24 hand brooms, 6 hand scrapers, 1 h. d. machine broom, 12 street cans, 1 h. d. sprinkling wagon, 2 dirt wagons, 6 snow plows	.....	.....
South Bend	..	..	..	60 hand brooms, 12 hand scrapers, 4 motor machine brooms, 2 Elgin sweepers, 2 Elgin gutter machines, 16 can carriers, 50 street cans, 1 motor flushing machine, 1 motor sprinkling wagon, 6 dirt wagons, 30 snow plows	.....	.....
Valparaiso	1	6	18	12 hand brooms, 1 h. d. machine broom, 1 dirt cart, 6 snow plows	.....	Machine brooms after a rain
Wabash	10½	..	..	24 hand brooms, 7 hand scrapers, 4 street cans, 1 h. d. sprinkling wagon, 1 dirt wagon, 4 dirt carts, 6 snow plows	All kinds	Pickup sweeper; hand brooms for business dist.
Iowa:						
Marshalltown	2	5	40	24 hand brooms, 12 cans, 1 motor flushing machine, 4 dirt wagons	.....	.....
Mason City	..	..	..	20 hand brooms, 12 hand scrapers, 1 h. d. machine broom, 1 h. d. sprinkling wagon, 4 dirt wagons, 2 snow plows	.....	.....
Red Oak	..	..	..	12 hand brooms, 1 h. d. machine broom, 20 street cans, 1 h. d. sprinkling wagon	All kinds	Machine brooms best for small city
Kansas:						
Salina	10	2	..	36 hand brooms, 1 h. d. machine broom, 1 gutter sweeping machine, 6 can carriers, 20 street cans, 1 h. d. flushing machine, 1 motor flushing machine, 2 h. d. sprinkling wagons, 1 motor sprinkling wagon, 10 dirt wagons, 4 dirt carts	.....	.....
Kentucky:						
Bowling Green	2	..	..	36 hand brooms, 36 hand scrapers, 1 h.d. machine broom, 4 pickup sweepers, 4 can carriers, 50 street cans, 4 dirt trucks 12 hand brooms, 1 h. d. sprinkling wagon	All kinds	Motor sweeper, because of cost
Fort Thomas	..	..	..		.....	.....
Frankfort	..	4	..	24 hand brooms, 1 h. d. machine broom, 1 h. d. flushing machine, 1 h. d. sprinkling wagon, 2 dirt wagons, 1 snow plow	.....	Flush dirt into gutter and pick up by hand
Madisonville	0.9	2	14	24 hand brooms with scrapers, 2 h. d. machine brooms, 2 can carriers, 4 street cans, 1 h. d. sprinkling wagon	.....	Flusher more sanitary
Paducah	..	..	..	15 hand brooms, 6 hand scrapers, 1 h. d. machine broom, 1 can carrier, 4 street cans, 2 h. d. flushing machines, 2 h. d. sprinkling wagons, 7 dirt wagons, 1 dirt cart, 2 snow plows	Bit., conc., brick Wood block, macadam	Flusher Machine broom—Flushing injures these
Winchester	..	..	..	Hand brooms, scrapers, dirt wagons and dirt carts—numbers not given	.....	.....
Maine:						
Oldtown	0.1	..	..	24 hand brooms, 3 hand scrapers, 15 cans, 1 h. d. sprinkling wagon, 1 dirt wagon, 4 snow plows	.....	.....
So. Portland	..	..	..	12 hand brooms, 1 h. d. machine broom	.....	.....
Maryland:						
Hagerstown	5	25	50	100 hand brooms, 5 can carriers, 10 street cans, 1 motor flushing machine, 1 h. d. sprinkling wagon, 1 motor sprinkling wagon, 3 trucks	.....	.....
Massachusetts:						
Adams	4	..	..	36 hand brooms, 1 h. d. machine broom, 1 motor machine broom, 6 can carriers, 24 cans, 1 h. d. sprinkling wagon, 1 dirt cart, 6 snow plows	Bit., concr., brick, stone blk., wood blk. Macadam	Motor broom—Gives perfect satisfaction. H. d. sweeper.

Andover	..	..	..	10 hand brooms, 1 h. d. machine broom, 2 h. d. sprinkling wagons, 1 dirt cart, 1 "hokey-poky" cart, 10 snow plows	.....	.....
Athol	1	6	..	10 hand brooms, 1 h. d. machine broom, 6 cans, 4 h. d. sprinkling wagons, 2 dirt wagons, 3 dirt carts, 6 snow plows	.....	.....
Concord	0.5	2	30	30 hand brooms, 1 h. d. machine broom, 10 cans, 1 h. d. sprinkling wagon, 3 dirt carts, 13 h. d. snow plows, 3 auto snow plows	Bit.	Hand broom—Less dust.
Dartmouth	..	..	14	45 hand brooms, 2 h. d. machine brooms, 2 h. d. sprinkling wagons, 12 dirt carts, 2 snow plows	.....	.....
Dracut	1	..	15	12 hand brooms, 1 h. d. machine broom, 1 h. d. sprinkling wagon, 6 snow plows	.....	.....
Haverhill	15	..	..	50 hand brooms, 1 h. d. machine broom, 1 Elgin sweeper with gutter sweeper, 20 can carriers, 1 motor flushing machine and sprinkler, 3 dirt wagons, 15 snow plows	.....	.....
Holyoke	..	..	..	150 hand brooms, 15 hand scrapers, 2 h. d. machine brooms, 15 can carriers, 200 cans, 1 motor flushing machine, 6 h. d. sprinkling wagons, 1 motor sprinkling wagon, 1 squeegee, 12 dirt wagons, 12 dirt carts, 15 snow plows	Macadam All others.	H. d. broom. Flusher, cheaper.
Hudson	75	..	..	24 hand brooms, 1 h. d. machine broom, 1 can carrier, 30 cans, 1 h. d. sprinkling wagon, dirt carts, 6 snow plows	Bit. macadam	Hand brooms daily; h. d. sweeper once a month.
Ludlow	..	..	4	6 hand brooms, 2 cans, 1 h. d. sprinkling wagon, 4 snow plows	.....	.....
Malden	5	..	..	144 hand brooms and scrapers, 2 h. d. machine brooms, 1 motor machine broom, 1 pickup sweeper, 4 can carriers, 24 cans, 1 motor flushing machine, 2 road snow plows, 2 sidewalk snow plows	.....	.....
Mansfield	..	..	..	6 hand brooms, 1 hand cart	.....	.....
Medford	5	10	40	60 hand brooms, 1 h. d. machine broom, 6 pickup sweepers, 2 gutter sweepers, 6 can carriers, 10 cans, 1 motor flushing machine, 2 h. d. sprinkling wagons, 6 dirt wagons, 21 snow plows	Bit., concr. stone blk., wood blk.	Motor.
Newburyport	5	5	20	30 hand brooms, 20 hand scrapers, 1 h. d. machine broom, 4 can carriers, 16 cans, 2 h. d. sprinkling wagons, 5 dirt wagons, 5 dirt carts, 7 snow plows	.....	.....
Newton	55	15	60	50 hand brooms, 3 h. d. machine brooms, 1 motor machine broom, 1 pickup sweeper, 25 cans, 1 motor flushing machine, 3 h. d. sprinkling wagons, 1 motor sprinkling wagon, 6 dirt carts and wagons, 50 snow plows	.....	.....
No. Attleboro	0.4	..	..	36 hand brooms, 24 hand scrapers, 1 can carrier, 8 cans, 1 h. d. sprinkling wagon, 2 dirt wagons, 2 dirt carts, 16 snow plows	.....	Motor broom for brk., h. d. broom for mac.
Orange	..	..	..		.....	.....
Rockland	2	7	..	1 dirt wagon, 6 snow plows 6 hand brooms, 25 snow plows	Business dist.	Hand brooms only.
Watertown	..	..	..	36 hand brooms, 1 machine broom (h. d.), 1 sprinkling wagon (h. d.), 10 dirt wagons, 10 dirt carts, 18 snow plows	.....	.....
Winchester	..	..	..	60 hand brooms, 2 h. d. machine brooms, 1 can carrier, 3 h. d. sprinkling wagons, 8 dirt carts, 12 snow plows	Bituminous and macadam	H. d. machine broom.
Michigan:						
Alma	3	3	40	1 h. d. flushing machine, 2 h. d. sprinkling wagons, 3 dirt wagons, 4 snow plows	Bit., conc., brick	Flusher—Minimum expense.
Ann Arbor	5	20	..	24 hand brooms, 1 pickup sweeper, 1 h. d. sprinkling wagon, 2 dirt wagons, 14 snow plows	Bit., conc., brick, wood, business dist.	Pickup sweeper—Cheapest.
Detroit	36	750	..	720 hand brooms, 120 hand scrapers, 40 h. d. machine brooms, 10 motor-driven machine brooms, 5 pick up sweepers, 215 can carriers, 14 h. d. flush machines, 5 motor-driven flush machines, 3 h. d. sprink wagons, 5 dirt wagons, 8 snow plows	.....	.....
Highland Park	16	48	..	2 pickup sweepers, 1 gutter sweeper, 50 cans, 1 dirt truck.	.....	.....
Holland	9	..	..	12 hand brooms, 5 hand scrapers, 1 h. d. mach. broom, 1 h. d. flush. mach., 1 motor-driven flush. mach., 4 sprink. wagons (h. d.), 8 snow plows	.....	.....
Ishpeming	27	..	..	12 hand brooms, 6 hand scrapers, 1 h. d. mach. broom, 1 motor-driven sprink. wagon, 1 dirt wagon, 6 dirt carts, 4 snow plows, trucks	Conc., brick, stone, wood, macadam, business.	Truck.
Jackson	5	5	..	50 hand brooms, 2 h. d. mach. brooms, 2 can carriers, 1 m. d flush. mach., 2 h. d. sprink. wagons, 6 dirt wagons.	Bit., conc., brick.	Flusher—No experience with other equip.
Kalamazoo	8	4	20	24 hand brooms, 6 hand scrapers, 3 h. d. machine brooms, 1 motor machine broom, 10 pickup sweepers, 6 cans, 1 h. d. sprinkling wagon, 4 dirt wagons, 30 snow plows.	Bit., wood, macadam, concr., brick, stone	Sweeper.
Lansing	10	..	..	72 hand brooms, 6 hand scrapers, 1 h. d. mach. broom, 1 m. d. mach. broom, 1 pickup sweeper, 1 gutter sweeper, 6 can carriers, 1 h. d. flush mach., 16 h. d. sprink wagons, 4 m. d sprink. wagons, 4 dirt wagons, 48 snow plows.	Bit., bus. dist. Conc., brick	Motor-driven. Horse-drawn.

STREET CLEANING—(Continued)

City	Miles of Street Cleaned: Daily	1 to 3 Times a Week	Less Than Once a Week	Equipment Owned by City	Equipment Preferred for Use on Each Kind of Pavement: Kind of Pavement	Equipment Preferred
Michigan (Continued):						
Ludington	4	2	..	2 hand brooms, 2 hand scrapers, 2 snow plows.	Bit.	Scraper.
Monroe	5	3	..	1 h. d. machine broom, 1 motor machine broom, 30 cans, 1 h. d. sprink. wagon, 2 dirt wagons, 6 snow plows.	Macadam All kinds	Broom—More efficient. Flusher, dustless.
Muskegon	5	5	10	24 hand brooms, 6 hand scrapers, 1 h. d. mach. broom, 1 m. d. mach. broom, 1 pickup sweeper, 1 gutter sweeper, 1 h. d. flush mach., 1 h. d. sprink. wagon, 4 dirt wagons, 3 dirt carts.	Brick Stone, wood, mac.	Hand sweeper. Motor sweeper.
Niles	1	3	..	1 h. d. mach. broom, 2 dirt carts, 6 snow plows.	Bus. district.	Carts.
Pontiac	10	..	..	48 hand brooms, 36 hand sweepers, 1 h. d. mach. broom, 3 can carriers, 1 m. d. flush. mach., 4 dirt wagons, 14 snow plows.	Bituminous, concrete Brick, stone, wood.	Flusher. Sweeper—Not injurious.
Sturgis	..	12	..	1 h. d. mach. broom, 4 can carriers, 1 h. d. flush. mach., 1 h. d. sprink. wagon, 2 dirt wagons, 2 snow plows.	Bit., wood & res. dist., Brick, stone, bus. dist.	Pickup sweeper. Flusher—Best where practicable.
Minnesota:						
Austin	..	5	..	6 hand brooms, 3 hand scrapers, 1 h. d. mach. broom, 1 m. d. flush. mach., 6 dirt wagons, 5 one-horse snow plows, 2 F. W. D. trucks part time.	Brick & wood.	Flusher.
Rochester	10	25	40	1 h. d. flush. mach., 1 m. d. flush. mach., 5 h. d. sprink. wagons, 1 m. d. sprink. wagon, 4 dirt wagons, 10 snow plows.	Bit. conc., brick, wood,	Flusher.
St. Paul	..	..	..	110 hand brooms, 96 hand scrapers, 181 cans, 7 h. d. flush. machines, 3 motor combined flusher and sprinkler, 106 h. d. sprink. wagons, 4 dirt wagons, 32 snow plows.	business & res. All kinds.	Flushing only proper and economical method.
Mississippi:						
Vicksburg	..	..	..	36 hand brooms, 1 motor flushing machine, 3 dirt carts.	.....	.....
Missouri:						
Cape Girardeau	12	..	..	36 hand brooms, 6 can carriers.	.....	.....
Columbia	..	..	..	10 hand brooms, 1 h. d. mach. broom, 1 can carrier, 1 h. d. flush. mach., 1 h. d. sprink. wagon, 2 dirt wagons, 2 snow plows.	.....	.....
Fulton	..	½	..	12 hand brooms, 1 h. d. machine broom, 10 cans, 1 h. d. sprink. wagon, 2 dirt wagons, 1 snow plow, fire hose.	Brick.	Use machine broom, prefer flusher—Less dust.
Joplin	10	10	..	4 hand brooms, 1 pickup sweeper, 1 dirt wagon.	.....	.....
Kansas City	15	175	510	400 hand brooms, 2 h.d. machine brooms, 1 Elgin cleaner, 1 Elgin gutter sweeper, 50 can carriers, 1,100 cans, 21 h.d. flushing machines, 2 h.d. sprinkling wagons, 4 dirt wagons, 45 dirt carts, 6 snow plows.	Wood block and macadam All other pavements	Hand brooms Elgin cleaner
Sedalia	2	3	..	24 hand brooms, 1 h. d. mach. broom, 2 can carriers, 1 h. d. flush. mach., 2 dirt wagons, 1 dirt cart.	.....	.....
Montana:						
Kalispell	2	..	..	4 hand brooms, 1 h.d. mach. broom, 4 h.d. sprink wagons, 2 dirt carts, 5 snow plows.	Bituminous.	Flushing machines.
Nebraska:						
Hastings	2	6	20	14 hand brooms, 1 h.d. mach. broom, 3 dirt wagons, 4 snow plows.	.....	.....
New Hampshire:						
Franklin	1	1	..	12 hand brooms, 2 hand scrapers, 1 h.d. mach. broom., 2 pickup sweepers, 2 can carriers, 1 h.d. sprink wagon, 1 dirt cart, 6 snow plows.	.....	Hand broom only necessary.
Nashua	..	..	..	1 h.d. mach. broom, 1 Elgin sweeper, 20 snow plows.	.....	Elgin sweeper on all.
New Jersey:						
Asbury Park	2	..	..	72 hand brooms and scrapers, 4 can carriers, 8 motor sprink. wagons, 5 dirt wagons, 8 snow plows.	All paved streets.	Hand sweeping.
Atlantic City	50	34	..	100 hand brooms, 16 hand scrapers, 2 m.d. flush. mach., 8 h.d. sprink. wagons, 1 m.d. sprink. wagon, 6 snow plows, 15 hand trucks.	.....	.....

Hackensack	8	..	..	1 Elgin sweeper, 1 h.d. flush. machine, 1 h.d. sprink. wagon, 2 dirt carts, 2 snow plows.	Bit., concr., brick, stone. Macadam.	Elgin at night. Hand brooms.
Newark	35	225	22	350 hand brooms, 150 hand scrapers, 1 m.d. mach. broom, 20 can carriers, 3 h.d. flush. mach., 4 m.d. flush. mach., 3 h.d. sprink. wagons, 40 dirt wagons, 9 snow plows.	Macadam & some stone blk. All others.	Hand brooms. ..... Motor flusher—Insures clean pavements.
Phillipsburg	2	..	31	15 hand brooms, 2 can carriers, 6 cans, 1 h.d. sprink. wagon.	Concr., brick, stone.	Hand brooms.
Roselle Park.....	..	..	4	6 hand brooms, 1 h.d. mach. broom, 1 h.d. sprink. wagon, 1 dirt wagon, 2 dirt carts, 2 snow plows.	All impvd. concrete.	.....
Salem	..	..	..	4 hand brooms, 1 h.d. mach. broom, 2 h.d. sprink wagons.	.....	.....
Westfield	2	10	20	24 hand brooms, 1 h.d. mach. broom, 3 can carriers, 1 h.d. sprink. wagon, 2 dirt wagons, 2 dirt carts, 3 snow plows.	.....	.....
West Orange.....	..	..	11	24 hand brooms, 24 hand scrapers, 1 h.d. mach. broom, 1 m.d. mach. broom, 6 can carriers, 1 h.d. sprink. wagon, 3 dirt wagons, 2 dirt carts, 4 snow plows.	Bit., conc., stone, macadam, bus. dist.	Motor sweeper.
New York:						
Amsterdam	10	5	..	96 hand brooms, 96 hand scrapers, 2 h.d. mach. brooms, 1 m.d. mach. broom, 1 pickup sweeper, 1 vacuum str. cleaner, 1 gutter sweeper, 12 can carriers, 1 h.d. sprink. wagon, 12 squeegees, 6 dirt wagons, 15 dirt carts, 1 snow plow.	.....	.....
Auburn	..	..	..	24 hand brooms, 36 hand scrapers, 1 h.d. mach. broom, 10 can carriers, 1 m.d. flush. mach., 2 h.d. sprink. wagons, 1 Ford truck, 1 Mack 5-ton truck (part time).	.....	.....
Buffalo	465*	..	..	225 hand brooms and scrapers, 25 h.d. machine brooms, 80 can carriers, 30 cans, 15 motor flush. mach., 7 h.d. sprink. wagons, 85 dirt wagons, 15 snow plows.	.....	.....
Cortland	1	4	15	18 hand brooms, 10 hand scrapers, 2 h.d. sprink. wagons, 4 dirt wagons, 6 snow plows.	Bit., bus. dist. Brick, macadam, res. dist.	Brooms Scrapers
Hempstead	2	5	15	12 hand brooms, 2 hand scrapers, 1 h.d. mach. broom, 1 m.d. mach. broom, 1 can carrier, 1 m.d. sprink. wagon, 3 dirt wagons, 3 dirt carts, 1 snow plow.	.....	.....
Johnson City.....	4	5.5	..	12 hand brooms, 8 hand scrapers, 5 can carriers, 1 m.d. flush. mach., 1 h.d. sprink. wagon, 2 dirt wagons, 1 snow plow.	Macadam All others	Sweeper Flusher.
Kingston	25	25	50	60 hand brooms and scrapers, 2 h.d. machine brooms, 25 can carriers, 50 cans, 2 h.d. flush. mach., 1 motor flushing mach., 1 h.d. sprink. wagon, 1 squeegee, 3 dirt wagons, 1 snow plow.	Bituminous Conc. & macadam Brick & wood block Stone block Business dist.	Motor flusher and white wings Flusher Flusher and sweeper Sweeper White wings
New York (Manhattan, Brooklyn and Bronx Boroughs)	1,600	..	..	3,000 hand brooms, 15,000 hand scrapers, 132 h.d. machine brooms, 3,400 can carriers, 21,500 cans, 87 motor flushers, 99 h.d. sprinkling wagons, 30 squeegees, 110 bottom-dump wagons, 2 snow loading machines, 300 push snow plows, 129 5-ton trucks, 12 7.5-ton trucks, 100 2-ton trucks, 129 tractors.	.....	.....
Ossining	5	4	..	4 hand brooms, 1 h.d. mach. broom, 1 h.d. sprink. wagon, 3 dirt wagons, 2 snow plows.	.....	Pickup sweeper on all—Removes all refuse at one operation
Rockville Centre..	..	..	..	12 hand brooms, 2 hand scrapers, 1 m.d. mach. broom, 2 can carriers, 1 h.d. sprink. wagon, 2 dirt wagons.	All	Hand broom—More sanitary and neat
Saratoga	2	..	..	25 hand brooms, 3 h.d. mach. brooms, 6 pickup sweepers, 18 cans, 1 h.d. flush. mach., 6 h.d. sprink. wagons, 6 dirt wagons.	Bit., conc., brick, stone, wood Macadam	Flusher Brooms
Tarrytown	¼	3	..	30 hand brooms, 1 h.d. mach. broom, 1 can carrier, 2 h.d. sprink. wagons, 5 snow plows.	Bit., brick, mac., bus. & res.	Hand broom
Watertown	10	3	..	12 hand brooms, 1 gutter sweep., 3 can carriers, 1 dirt wagon	.....	Elgin str. sweeper on all smooth surfaces; does not clog catch basins nor sewers.
North Carolina:						
Durham	2	6	..	2 hand brooms, 1 h.d. mach. broom, 1 pickup sweeper, 1 gutter sweeper, 2 can carriers, 1 m.d. flush. mach., 2 h.d. sprink. wagons, 1 m.d. spr. wagon, 3 dirt wagons, 12 dirt carts.	.....	.....
Elizabeth City....	2	8	1	72 hand brooms, 1 m.d. mach. broom, 2 pickup sweepers, 1 h.d. sprink. wagon, 4 dirt wagons, 4 dirt carts.	Bit. & conc.	Truck
Fayetteville	10	25	5	36 hand brooms, 6 hand scrapers, 1 m.d. mach. broom, 5 can carriers, 1 m.d. sprink. wagon, 3 dirt wagons, 3 dirt carts.	Bit., conc., stone, bus. and res. dist. Brick, wood block	Flusher—Sanitary and cheaper Broom
Greensboro	..	..	..	120 hand brooms, 150 cans, 1 h.d. flush. mach., 1 motor flush. mach., 1 h.d. sprink. wagon, 1 motor sprink. wagon, 8 dirt wagons, 4 dirt carts.	.....	.....
Henderson	1	3	6	48 hand brooms, 48 hand scrapers, 1 h.d. mach. broom, 1 h.d. sprink. wagon, 1 dirt wagon.	Bituminous Conc., brick	Vacuum Flusher.
Wilmington	3	15	..	2 h.d. mach. brooms, 1 m.d. flush. mach., 1 h.d. sprink wagon, 3 dirt wagons, 6 dirt carts.	Bit., bus. & res. dist. Brick & stone block	Flusher—Saves expense of pickup. Broom

*275 miles of street cleaning and 190 miles of flushing per day.

STREET CLEANING—(Continued)

City	Miles of Street Cleaned: Daily	1 to 3 Times a Week	Less Than Once a Week	Equipment Owned by City	Equipment Preferred for Use on Each Kind of Pavement: Kind of Pavement	Equipment Preferred
North Dakota:						
Jamestown	20 blks.	..	..	2 hand brooms, 2 hand scrapers, 2 dirt wagons, 1 dirt cart, 1 flusher and sprinkler, 1 snow plow.	Bit., mac., bus. dist. Conc., wood blk. Brick, stone blk. Res. dist.	Flusher Pickup sweeper Machine broom Sprinkler } Different equipment does better work under different conditions.
Ohio:						
Akron	..	..	..	96 hand brooms, 6 m.d. mach. brooms, 3 pickup sweepers, 2 gutter sweepers, 100 can carriers, 2 m.d. flush. mach., 7 2-ton motor trucks, 10 snow plows.	.....	Motor on all; easier on pavements; better work; low cost.
Ashland	2	..	..	12 hand brooms, 1 h. d. mach. broom, 6 pickup sweepers, 2 dirt wagons, 6 snow plows	.....	.....
Ashtabula	5	11	..	260 hand brooms, 6 hand scrapers, 2 h. d. mach. brooms, 3 can carriers, 3 h. d. sprink. wagons, 4 dirt wagons, 1 dirt cart, 14 snow plows, 72 shoveis, 12 catch basin spoons	.....	Brooms, because they clean better
Bellefontaine	1½	2	..	6 hand brooms, 3 hand scrapers, 2 snow plows	.....	.....
Bucyrus	..	15	20	24 hand brooms, 3 hand scrapers, 2 h. d. mach. brooms, 1 motor d. mach. broom, 1 dirt wagon, 1 dirt cart, 6 snow plows	.....	Motor on all—cheaper operation
Chillicothe	6	9	5	24 hand brooms, 36 hand scrapers	.....	Motor driven machine broom on all
Cincinnati	15	30	30	200 hand brooms, 200 hand scrapers, 2 pickup sweepers, 50 can carriers, 2 h. d. flush. mach., 4 motor d. flush. mach., 15 dirt wagons, 6 snow plows	Bit., brick, wood, bus. and res. dist. Macadam	Flushing machine Pickup sweeper
Circleville	..	3	..	24 hand brooms, 1 h. d. mach. broom, 1 h. d. flush. mach., 1 h. d. sprink. wagon, 1 dirt wagon, 1 snow plow	.....	Hand broom—can sweep till clean
Dayton	5	..	..	21 hand scrapers, 14 can carriers, 1 motor d. flush. mach., 5 dirt wagons, 4 snow plows, 3 pick trucks	.....	.....
Delaware	..	9	..	24 hand brooms, 1 h. d. mach. broom, 1 h. d. flush. mach., 1 h. d. sprink. wagon, 6 snow plows	Bit., conc., brick, stone, bus. and res. dist. Wood block Macadam	Flusher Sweeper Sprinkler } Best results
Fremont	..	..	..	12 hand brooms, 1 h. d. mach. broom, 1 h. d. sprink. wagon, 2 dirt carts	.....	.....
Galion	2	1	8	36 hand brooms, 6 hand scrapers, 6 can carriers, 1 h. d. flush. mach., 1 h. d. sprink. wagon, 1 dirt cart, 6 snow plows	Brick, stone, macadam Bus. dist. Res. dist.	Hand broom White wings Flusher
Newark	3-5	..	..	36 hand brooms, 12 hand scrapers, 1 h. d. mach. broom, 1 h. d. flush. mach., 3 dirt wagons, 1 dirt cart, 1 snow plow	Bit., brick, bus. and res. dist.	Flusher—no dust—cleans better
Portsmouth	6	..	..	6 hand brooms, 6 hand scrapers, 2 h. d. mach. brooms, 1 h. d. sprink. wagon, 2 dirt wagons, 1 snow plow	.....	Only brick pavements
Sidney	9	..	..	12 hand brooms, 5 hand scrapers, 1 h. d. flush. mach., 2 dirt wagons	.....	.....
Urbana	2	2	..	12 hand scrapers, 1 h. d. mach. broom, 3 can carriers, 1 h. d. flush. mach., 3 h. d. sprink. wagons, 3 dirt carts, 3 snow plows	Bit., conc., br., mac., bus. and res. dist.	Flusher—more sanitary—cheaper—cleaner
Wilmington	..	..	..	6 hand brooms, 2 hand scrapers, 1 h. d. mach. broom, 1 cart, 1 h. d. sprink. wagon, 3 dirt wagons	.....	.....
Oklahoma:						
Ada	..	2	2	4 hand brooms, 2 hand scrapers, 1 h. d. mach. broom, 1 motor d. flush. mach., 1 h. d. sprink. wagon, 2 dirt wagons, 1 dirt cart	Bit., conc., bus. and res. dist. Macadam	Flusher Sprinkler
Blackwell	..	..	..	4 hand brooms, 1 h. d. sprink. wagon, 1 dirt wagon, 2 dirt carts	.....	.....
Enid	1½	6	30	8 hand brooms, 6 hand scrapers, 1 h. d. sprink. wagon, 1 dirt wagon, 3 dirt carts	.....	.....
Oregon:						
Corvallis	..	..	..	12 hand brooms, 1 h. d. mach. broom, 1 h. d. flush. mach., 1 dirt wagon	.....	.....
La Grande	1	3	4	6 hand brooms, 6 hand scrapers, 1 h. d. mach. broom, 1 can carrier, 1 h. d. flush. mach., 1 h. d. sprink. wagon, 1 dirt wagon, 1 dirt cart	Bituminous Conc., br., stone, res. dist. Macadam Bus. dist.	Squeegee Pickup sweeper Sprinkler Flusher
Pendleton	1.2	4.7	18	5 hand brooms, 1 h. d. mach. broom, 1 motor d. flush. mach., 4 h. d. sprink. wagons, 1 motor truck	Bit., res. dist. Conc., bus. dist.	Pickup sweeper Flusher

Pennsylvania:						
Beaver Falls	..	..	..	24 hand brooms, 1 h. d. machine broom, 12 cans, 1 h. d. flushing machine and sprinkler, 3 dirt wagons	Bit., conc., brick	Machine broom
Bloomsburg	..	..	..	60 hand brooms, 1 dirt truck, 1 snow plow	.....	.....
Carlisle	2	7	..	24 hand brooms, 12 hand scrapers, 4 can carriers, 2 dirt wagons	.....	.....
Coatesville	..	..	..	12-15 hand brooms, 1 h. d. mach. broom, 1 h. d. sprink. wagon, 3 dirt wagons, 1 dirt truck	Asph., br., stone, wood Mac., bus. and res. dist.	Machine broom Hand broom Less dust on macadam
Dormont	..	3	12	12 hand brooms, 1 can carrier, 1 dirt cart, 1 snow plow	.....	.....
Du Bois	1	2	..	24 hand brooms, 1 h. d. mach. broom, 2 can carriers, 1 h. d. flush. mach., 1 h. d. sprink. wagon, 2 dirt wagons, 1 snow plow	.....	.....
Easton	..	..	..	1 h. d. flushing machine, 1 h. d. sprinkling wagon, 1 pickup sweeper	.....	.....
Freeland	..	3	2	24 hand brooms, 10 hand scrapers, 2 can carriers, 2 dirt wagons, 2 dirt carts, 1 snow plow	.....	.....
Greenville	..	..	..	10 hand brooms, 5 hand scrapers, 3 h. d. machine brooms, 1 h. d. flush. machine, 1 h. d. sprink. wagon, 2 dirt wagons	Bit., bus. dis. Conc., brick, stone, wood, macadam	Flusher—cleaner and better Sweeper—cheaper and quicker
Kittanning	1½	..	..	1 h. d. mach. broom, 1 h. d. sprink. wagon, 2 dirt trucks, 2 snow plows	.....	.....
Lebanon	6	10	..	15 hand brooms, 1 h. d. mach. broom, 1 Elgin sweeper	.....	.....
Lewistown	..	..	..	6 hand brooms, 1 dirt truck	.....	.....
Meadville	4	17.82	..	72 hand brooms, 12 hand scrapers, 3 h. d. mach. brooms, 1 Elgin sweeper, 3 can carriers, 1 h. d. sprink. wagon, 2 dirt wagons, 5 snow plows	All brick except 6 mi. asphalt	Sweeper
New Brighton	..	9	..	24 hand brooms, 1 h. d. flush. mach., 1 dirt wagon	.....	.....
No. Braddock	3	5	16	5 hand brooms, 1 h. d. mach. broom, 6 can carriers, 1 h. d. sprink. wagon, 3 dirt wagons	.....	.....
Pittston	6	2	..	24 hand brooms and scrapers, 6 can carriers, 96 cans, 1 h. d. sprink. wagon, 6 dirt wagons, 6 dirt carts	.....	.....
Rankin	2	6	..	50 hand brooms, 10 hand scrapers, 1 h. d. mach. broom, 5 can carriers, 1 h. d. sprink. wagon, 1 dirt wagon	Brick, stone, bus. and res. dist.	Hand broom—rough paving
Summit Hill	..	..	7 approx.	2 dirt trucks, 1 snow plow	.....	.....
W. Pittston	..	..	..	24 hand brooms, 6 hand scrapers, 12 cans, 1 dirt truck, 1 hose cart	.....	.....
Rhode Island:						
Westerly	2	..	6	30 hand brooms, 12 hand scrapers, 1 h. d. mach. broom, 3 can carriers, 1 h. d. flush. mach., 2 dirt wagons, 4 dirt carts, 4 snow plows	.....	.....
South Carolina:						
Spartanburg	5	6	8	24 hand brooms, 2 h. d. mach. brooms, 4 can carriers, 1 motor d. flush. mach., 2 h. d. sprink. wagons, 6 dirt wagons	Bit. conc., bus., res. dist. Brick, stone	Flusher Sweeper — Flusher eliminates dust
Tennessee:						
Memphis	77	40	10	96 hand brooms, 36 hand scrapers, 2500 lbs. fibre, motor d. mach. broom, 2 pickup sweepers, 25 can carriers, 8 h. d. flush. mach., 1 motor d. flush. mach., 21 h. d. sprink. wagons, 16 dirt carts	.....	Elgin and flusher preferred—one picks up heavy dust—other flushes fine
Morristown	..	..	..	100 hand brooms, 4 hand scrapers, 1 h. d. mach. broom, 1 h. d. flush. mach., 1 h. d. sprink wagon	Bit., conc., br., bus. and res. dist. Macadam	Motor driven sweeper Hand brush
Texas:						
Beaumont	20	20	..	12 hand brooms, 12 hand scrapers, 4 can carriers, 2 motor d. flush. mach., 6 dirt wagons, 2 dirt carts	Bit., conc., wood bl. Bus. dist. Res. dist.	Flushers—pickup Hand equipment Motor equipment — Cleanliness and appearance of equipment
Dallas	70	130	211	24 hand brooms, 48 hand scrapers, 3 Elgin sweepers, 36 can carriers, 6 m.d. flush. mach., 4 h.d. sprink. wagons, 2 m.d. sprink. wagons, 10 dirt wagons, 18 dirt carts, 20 motor trucks, dump bodies.	Bituminous	Flushers
Eagle Pass	..	..	..	24 hand brooms, 1 h.d. mach. broom, 2 can carriers, 1 h.d. sprink. wagon, 3 dirt wagons, 1 Ford truck & Peerless truck.	Bit., bus. dist. Macadam, res. dist.	Street sweeper Hand brooms
McKinney	..	..	..	1 h.d. mach. broom, 1 h.d. sprink. wagon, 1 dirt wagon.	.....	.....
Utah:						
Brigham	..	½	..	4 hand brooms, 1 comb. flush. & sprink. mach. (m.d.), 1 snow plow.	Bit., bus. dist.	Flusher
Vermont:						
Bennington	1	..	4	3 hand brooms, 1 h.d. mach. broom, 2 h.d. sprink wagons, 2 dirt wagons, 4 snow plows.	Bit., concrete	Hand brooms
Burlington	1	2	60	48 hand brooms and scrapers, 1 h.d. mach. broom, 6 can carriers, 13 h.d. sprink. wagons, 6 dirt wagons, 4 dirt carts, 13 snow plows.	.....	.....

STREET CLEANING—(Continued)

City	Miles of Street Cleaned: Daily	1 to 3 Times a Week	Less Than Once a Week	Equipment Owned by City	Equipment Preferred for Use on Each Kind of Pavement: Kind of Pavement	Equipment Preferred
Vermont—Continued						
Rutland	3	..	..	10 hand brooms, 2 hand scrapers, 1 h.d. mach. broom, 1 h.d. flush. mach., 2 h.d. sprink. wagons, 3 dirt wagons, 12 snow plows.	Bit., conc., br., bus. dist. Macadam, res. dist.	Flushing machine Sprinkler
Virginia:						
Bristol	2	2	..	24 hand brooms, 1 h.d. mach. broom, 1 h.d. flush. mach. & sprink. wagon (comb.), 2 dirt wagons.	.....	.....
Danville	4	25	..	Large No. hand brooms, 1 h.d. mach. broom, 1 pickup sweeper, 1 can carrier, 1 h.d. sprink. wagon, 2 dirt wagons.	.....	.....
Fredericksburg	1	7	10	20 hand brooms, 2 h.d. mach. brooms, 2 can carriers, 2 h.d. sprink. wagons, 2 dirt trucks, 1 snow plow.	.....	Pickup sweeper if finances permitted
Lynchburg	4	8	40	72 hand brooms, 2 h.d. mach. brooms, 4 can carriers, 3 h.d. sprink. wagons, 2 dirt wagons, 2 snow plows, 3 Ford trucks.	Bit., conc., br., wood, bus. & res. dist. Stone block	Pickup sweeper Machine brooms
Newport News	15	12	9	96 hand brooms, 3 h.d. mach. brooms, 1 can carrier, 1 h.d. sprink. wagon, 4 dirt carts.	Bit., conc., br., res. dist. Macadam, bus. dist.	Machine brooms } Efficiency Hand brooms }
Petersburg	5	13	10	3 h.d. mach. brooms, 1 mach. broom tractor, 1 pickup sweeper, 3 h.d. sprink wagons, 6 dirt carts.	Bit., conc., br., stone, wood, res. dist. Macadam Bus. dist.	Motor sweeper Tractor sweeper Patrol
Richmond	13.7	133	11	120 hand brooms, 24 hand scrapers, 4 h.d. machine brooms, 2 motor machine brooms, 2 pickup sweepers, 25 can carriers, 32 cans, 3 motor flushers, 2 h.d. sprink. wagons, 14 dirt carts, 4 snow plows.	.....	.....
Roanoke	4	36	..	7 hand brooms, 1 h.d. comb. mach. broom & sprinkler, 3 can carriers, 1 dirt wagon, 2 dirt carts.	.....	.....
Washington:						
Seattle	....	..	..	106 hand brooms, 50 hand scrapers, 60 can carriers, 1,200 cans, 14 h.d. flushing machines, 2 motor flushers, 3 h.d sprink. wagons, 1 squeegee, 55 dirt wagons, 2 dirt carts.	.....	.....
Spokane	30	10	..	20 hand brooms and scrapers, 4 motor machine brooms, 1 pickup sweeper, 1 gutter machine, 20 cans, 4 motor flushing machines, 10 h.d. sprink. wagons, 15 motor sprink. wagons, 1 snow plow.	.....	.....
Walla Walla	4	24	..	4 hand brooms, 1 hand scraper, 1 can carrier, 2 h.d. flush. mach., 2 m.d. flush. mach., 12 h.d. sprink. wagons, 2 m.d. sprink. wagons, 1 squeegee, 2 dirt wagons, 2 dirt carts, 8 h.d. snow plows.	.....	
West Virginia:						
Charleston	5	..	..	4 hand brooms, 4 can carriers, 2 h.d. flush. mach., 1 m.d. flush mach., 1 h.d. sprink. wagon, 7 dirt wagons, 3 dirt carts, 2 snow plows, 3 motor trucks.	Bit., bus. & res. dist. Conc., brick, macadam.	Flusher Sweepers
Clarksburg	7	18	45	36 hand brooms, 1 m.d. machine broom, 1 pickup sweeper, 1 gutter sweeper, 2 can carriers, 450 ft. hose & cart.	.....	Elgin—Most economical
Huntington	..	..	..	7 hand brooms, 1 m.d. machine broom, 1 pickup sweeper, 1 gutter sweeper, 1 h.d. sprink. wagon, 3 dirt wagons, 7 dirt carts.	Bit., conc., res. dist. Brick, macadam. Bus. dist.	Flushing machine Sweepers Push broom
Wisconsin:						
Ashland	9	1	..	24 hand brooms & scrapers, 1 h.d. mach. broom, 36 cans, 1 h.d. flush. mach., 3 h.d. sprink. wagons, 6 dirt wagons, 2 snow plows.	.....	.....
Green Bay	22	13	none	72 hand brooms & scrapers, 1 motor machine broom, 35 can carriers, 35 cans, 3 h.d. sprink. wagons, 6 dirt wagons, 3 snow plows.	Bit. or conc. Mac. & bus. dist.	Hand or machine brooms Hand brooms
Menasha	4	..	1	1 h.d. machine broom, 9 can carriers, 1 dirt wagon, 9 dirt carts, 1 snow plow.	.....	.....
Racine	7	43	..	32 hand brooms, 10 hand scrapers, 2 m.d. mach. brooms, 1 pickup sweeper, 1 gutter sweeper, 32 can carriers, 2 m.d. flush. mach., 12 dirt wagons, 32 dirt carts 2 snow plows.	Bit., wood, bus. dist. Conc., br., res. dist.	Hand broom—Can work with traffic Machine broom
Sheboygan	..	41	..	144 hand brooms, 36 hand scrapers, 1 m.d. flush. mach., 3 dirt trucks, 1 snow plow.	.....	.....
Wisconsin Rapids	..	..	..	50 hand brooms, 1 h.d. mach. broom, 1 pickup & gutter sweeper, 1 can carrier, 2 h.d. sprink. wagons, 3 dirt wagons.	.....	Motor pickup sweeper very satisfactory
Wyoming:						
Cheyenne	40 bus. blks.	..	..	1 h.d. sprink wagon, 2 dirt wagons, 2 dirt carts, 1 snow plow.	.....	.....

REFUSE COLLECTION

City	Population served	Area served, square miles	Classification of refuse collected	Equipment used for each class.
Alabama:				
Fairfield	5,700	2.5	Garbage.	3 mule-drawn wagons.
Mobile	70,000	25	Combined g., a. and r.	14 carts, 3 wagons, 1 motor truck
Selma	16,000	...	Garbage.	Cars.
Talladega	8,000	7.5	Garbage and refuse.	12 h. d. wagons, 1 Ford truck.
Arizona:				
Clifton	4,000	2	Combined.	2 Ford trucks.
Miami	7,000	1.1	Combined.	.....
Tucson	20,000	6	Combined.	.....
Arkansas:				
Helena	9,000	...	Combined.	.....
Pine Bluff	20,000	0.5	Trash.	Truck.
California:				
Alameda	30,000	...	"Wet garbage," "dry garbage,"	.....
Glendale	15,000	...	Garbage, ashes, rubbish.	.....
Long Beach	60,000	...	Garbage, rubbish.	Garbage—2 Fordson tractors, 10 Lee trailers, 6 h. d. wagons.
Marysville	7,000	2.5	Combined g., a., r.	.....
Monrovia	7,500	4	Garbage, cans.	Garbage, h. d. wagon; cans, motor truck.
Napa	7,000	...	Combined g., a., r.	.....
Oakland	220,000	...	Combined g., a., r.	.....
Ontario	5,000	2	Garbage, ashes, rubbish.	1 truck, 1 wagon.
Pitaluma	6,700	1.5	Garbage, rubbish.	2 dump wagons.
Richmond	18,000	...	Garbage, rubbish.	.....
Sacramento	70,000	...	.....	.....
San Bernardino	20,000	8	Garbage, rubbish.	.....
San Gabriel	3,000	3	Rubbish.	Auto truck.
Santa Ana	25,000	10	Paper; boxes and cans.	Two 2½-ton trucks.
Santa Barbara	25,000	13	Individual arrangements.	.....
So. Pasadena	10,000	2.5	Garbage, rubbish.	1 garbage truck, 1 rubbish wagon.
Colorado:				
Denver	267,000	56	Garbage, ashes, rubbish.	Horse and motor garbage wagons, ash wagons, large rubbish wagons.
Fort Collins	9,000	40	Garbage, ashes, paper	Motor wagon for paper.
Greeley	11,000	1	Garbage, ashes, rubbish.	H. D. wagons
Salida	.....	...	Garbage,rubbish (incl. ashes).	.....
Connecticut:				
Bridgeport	.....	..	Garbage, ashes.	Packard trucks and Lee trailers for both.
Bristol	14,000	1.5	Garbage, ashes.	Garbage, tank wagon. Ashes, wagon.
Hartford	140,000	17.5	Garbage; a. and r. combined.	Rubbish, 4½-yd. bottom dump wagons
Middletown	14,000	3	All combined.	Four 2-horse rear dump wagons.
New Britain	60,000	13	Garbage, other refuse.	.....
New Haven	165,000	..	Garbage.	.....
New London	25,000	5.8	Garbage, other refuse.	.....
Willimantic	12,000	46	Garbage.	.....
District of Columbia:				
Washington	425,000	45	Garbage, ashes, rubbish.	Garbage, 5 trucks, 85 wagons; ashes, 80 wagons, 3 trucks; rubbish, 26 wagons, 2 trucks.
Florida:				
Clearwater	.....	...	Garbage, rubbish.	Light truck.
Fort Myers	45,000	.75	Garbage, rubbish.	2 trucks.
Gainesville	6,000	...	Garbage, rubbish.	H. D. wagons.
Jacksonville	95,000	...	Garbage, rubbish.	Trucks and mule teams.
Sanford	6,000	4	Garbage.	.....
Georgia:				
Albany	16,000	4	Garbage, ashes, rubbish.	5 garbage carts, 1 garbage wagon, 1 ash wagon, 1 ash cart, 1 rubbish cart, 1 rubbish wagon.
Griffin	9,000	...	Garbage refuse.	.....
La Grange	12,000	4	Combined.	.....
Rome	15,000	3	Combined.	.....
Idaho:				
Boise City	22,000	...	Garbage, refuse.	.....
Pocatello	16,000	2.4	Garbage, ashes, rubbish and ashes.	Garbage, 1 wagon; ashes, 1 wagon; rubbish, 4 wagons.
Illinois:				
Blue Island	15,000	2	Garbage, ashes, rubbish.	Dump wagons.
Chicago	2,800,000	200	Garbage, other refuse.	136 garbage wagons, 3 tractors, 82 ash trailers, 635 ash wagons.
Chicago Heights	20,000	...	Garbage, other refuse.	Teams and trucks.
Evanston	38,000	...	Garbage, other refuse.	Garbage, six 1-horse wagons, 1 Ford truck.
Galesburg	27,696	9	Garbage; tin cans	4 garbage wagons.
Glencoe	.....	...	Garbage, other refuse.	Garbage, truck.
Kewanee	17,000	...	Garbage, rubbish.	.....
Murphysboro	11,000	...	Garbage.	Garbage, tank wagon.
Oak Park	46,000	4.5	Garbage, ashes, rubbish, tree trimmings.	9 garbage wagons, 2 ash trucks 2 ash wagons, 3 rubbish wagons.
Indiana:				
Bedford	1,000	2	Garbage.	1 garbage wagon.
Columbus	10,000	4	Garbage, other refuse.	1 garbage wagon, 4 h. d. rubbish wagons.
Lafayette	23,000	...	Garbage, cans	4 covered wagons.
Mishawaka	17,000	8	Garbage, other refuse.	Two 4-yard h. d. box wagons.
Peru	13,100	20	Garbage, cans.	2 garbage wagons.
Portland	6,000	..	Garbage, ashes.	.....
Richmond	27,000	4	Garbage, other refuse.	6 garbage wagons.
Shelbyville	11,000	31 lin. mi.	Garbage.	Garbage wagons.
South Bend	72,000	...	Garbage.	6 garbage wagons.
Terre Haute	68,000	...	Garbage.	.....
Valparaiso	7,000	...	.....	1 garbage wagon, 1 rubbish wagon.
Wabash	10,000	...	Garbage, ashes, rubbish.	2 garbage wagons, 1 ash wagon, 2 rubbish carts.
West Lafayette	3,500	...	Garbage, rubbish	.....

REFUSE COLLECTION—Continued

City	Population served	Area served, square miles	Classification of refuse collected.	Equipment used for each class.
Iowa:				
Cedar Rapids	47,000	13.2	Garbage	Truck and horse trailers.
Creston	8,500	...	Ashes.	.....
Dubuque	40,000	...	Garbage, ashes.	.....
Mason City	20,000	20	Garbage.	Water-tight wagons.
Muscatine	17,000	...	Garbage.	.....
Red Oak	6,000	...	Garbage.	.....
Kansas:				
Independence	12,000	...	Garbage.	Zinc lined wagons.
Salina	10,000	2.5	Garbage, other refuse.	4 garbage wagons, 10 rubbish carts, 4 rubbish wagons.
Kentucky:				
Fort Thomas	6,500	12	Garbage, other refuse.	Garbage, can-carrying wagon; rubbish wagons.
Louisiana:				
Lake Charles	14,000	...	Tin cans.	.....
New Orleans	390,000	...	Combined.	Tractors and trailers.
Maine:				
Oldtown	5,000	0.8	Combined.	1 rubbish cart.
Maryland:				
Hagerstown	28,000	3	Garbage, cans.	.....
Massachusetts:				
Adams	15,000	4	Garbage.	1 garbage cart.
Beverly	23,000	...	Garbage, other refuse.	.....
Brockton	68,000	...	Garbage, other refuse.	Garbage, 1 truck, 16 1-horse wagons; rubbish, 1 truck, 4 2-horse and 4 1-horse wagons.
Cambridge	110,000	...	Garbage.	H. d. tight wooden carts.
Fall River	122,000	...	Garbage, other refuse.	H. d. tight wagons.
Fitchburg	42,000	...	Garbage, other refuse.	.....
Haverhill	40,000	100 lin. mi.	Garbage, ashes, rubbish.	10 ash carts; garbage, contract.
Holyoke	62,000	23	Garbage, other refuse.	24 rubbish wagons, 1-horse; garbage, 6 2-horse.
Ludlow	1,600	9	Garbage, ashes, rubbish.	Garbage wagon, dump cart.
Lynn	100,000	...	Garbage, other refuse.	.....
Malden	50,000	...	Garbage, ashes, paper.	2 garbage carts, 7 garbage wagons, 2 ash motor trucks, 12 carts.
Medford	40,000	...	Garbage, rubbish, paper.	6 garbage carts, 3 ash trucks, 2 ash wagons, 4 ash carts, 2 rubbish carts.
Middleboro	5,000	72	Garbage, rubbish.	.....
New Bedford	122,000	...	Garbage, rubbish, ashes.	.....
Newburyport	16,000	2	Garbage, other refuse.	.....
North Adams	22,282	...	Garbage.	.....
Newton	47,000	18	Garbage, ashes, rubbish.	Garbage, contract—4 ash wagons, 10 ash carts, 3 rubbish carts.
No. Andover	7,000	...	Garbage, ashes.	.....
Orange	6,000	...	Rubbish.	1 cart.
Peabody	20,000	...	Garbage, ashes, rubbish.	.....
Rockland	2,500	...	Combined.	1 cart.
Waltham	31,000	...	Garbage, other refuse.	Garbage, 5 single and 1 double team; rubbish, truck and teams.
Watertown	22,000	4.3	Garbage, ashes, paper.	2 garbage carts, 2 garbage wagons, 10 ash wagons, 10 ash carts, 2 rubbish carts.
Winchester	9,000	7	Garbage.	2 garbage wagons.
Worcester	180,000	...	Garbage.	22 2-horse teams, 2 trucks.
Michigan:				
Alma	7,500	6	Garbage, ashes, rubbish.	Ashes and rubbish, dump wagons.
Ann Arbor	35,000	2	Garbage.	Private wagons.
Detroit	1,200,000	80	Garbage, other refuse.	Garbage wagons and trucks; rubbish, 337 wagons, 38 trucks.
Flint	110,000	30	Garbage, ashes and rubbish, cans and crockery.	Garbage—12 1-ton and 4 2-ton motor trucks, 6 tractors and 5 10-ton trailers; ashes and rubbish, motor trucks and wagons.
Highland Park	48,000	4	Garbage, rubbish	5 garbage motor trucks, 7 ash trucks, 3 rubbish trucks.
Holland	8,000	1	Garbage, ashes, rubbish.	Private equipment.
Ishpeming	12,000	9	Garbage, ashes.	Garbage—1 wagon, 1 cart; ashes—1 motor truck, 1 wagon; rubbish—6 carts, 1 wagon.
Jackson	35,000	9	Garbage, ashes.	Garbage—8 tank wagons.
Kalamazoo	20,000	3	Combined.	Contract.
Lansing	60,000	48	Garbage, ashes, rubbish.	Garbage—8 motor trucks; rubbish—6 carts.
Ludington	10,000	1.5	Garbage, tin cans.	.....
Monroe	5,000	1	Combined.	Garbage—1 cart, 1 wagon; ashes—2 trucks, 1 wagon.
Muskegon	4,100	...	Combined.	4 1-ton trucks, 3 carts, 4 wagons.
Owosso	14,000	...	Garbage.	.....
Pontiac	35,000	7	Garbage, ashes, rubbish.	Garbage—trucks and trailers; rubbish—trucks.
Sturgis	7,000	1.5	Garbage.	1 wagon with trailer.
Minnesota:				
Austin	2,000	2.8	Combined.	1 garbage wagon.
Ely	5,000	...	Garbage, other refuse.	1 water-tight wagon.
Minneapolis	385,000	...	Garbage.	.....
Rochester	15,000	6	Garbage	3 wagons, 2 motor trucks.
St. Paul	240,000	54	Garbage	40 garbage wagons.
Mississippi:				
Hattiesburg	.....	...	Garbage, rubbish.	.....
Natchez	.....	...	Combined	8 carts.
Vicksburg	15,000	3	Combined	7 carts, 2 wagons.
Missouri:				
Columbia	.....	0.1	Combined	.....
Joplin	.....	...	Garbage.	.....
Sedalia	22,000	...	Combined.	Dump wagons.
Montana:				
Havre	.....	...	Combined	.....
Kalispell	6,000	2	Combined.	1 wagon, 2 rubbish carts.

REFUSE COLLECTION—Continued

City	Population served	Area served, square miles	Classification of refuse collected.	Equipment used for each class.
Nebraska:				
Hastings	300	...	Garbage.	.....
Lincoln	.....	...	Combined.	.....
Omaha	.....	...	Garbage.	.....
New Hampshire:				
Dover	...	...	Garbage, ashes, rubbish.	.....
Franklin	6,500	20	Ashes, other refuse.	1 cart, 1 wagon, 1 motor truck
Laconia	.....	...	Ashes, rubbish.	.....
Nashua	29,000	...	Garbage, ashes, combustible.	3 motor trucks, 4 ash wagons, 1 rubbish cart.
New Jersey:				
Asbury Park	75,000	1	Garbage, ashes, rubbish.	Contract.
Atlantic City	.....	7	Garbage, other refuse.	Refuse—16 wagons.
Freehold	5,000	¾ sq. mi.	Garbage.	.....
Hackensack	18,000	4	Combined.	6 bottom-dump wagons.
Montclair	31,000	3,940 acres	Garbage, ashes and rubbish.	4 2½-ton Packard (garbage) trucks, rubbish, 5 carts (7 cu. yd.). Ashes, 10 3½ cu. yd. teams.
Newark	41,524	20 sq. mi.	Garbage, ashes and rubbish.	.....
Phillipsburg	17,000	3	Garbage, ashes.	Contract.
Roselle Park	6,000	2 sq. mi.	Garbage and ashes.	.....
Westfield	6,000	1,000 homes	Combined.	.....
New York:				
Amsterdam	36,000	6½ sq. mi.	Garbage and rubbish.	.....
Auburn	36,500	...	.....	3 motor trucks, 1 garbage wagon.
Buffalo	600,000	42	Garbage, ashes and rubbish.	21 tractors, 50 garbage trailers, 165 ash wagons, 42 rubbish wagons.
Hempstead	7,500	25 mi.	Garbage, tin cans, bottles, ashes.	2 Ford trucks.
Johnson City	10,000	1 sq. mi.	.....	.....
Kingston	30,000	7	Garbage, ashes.	7 1-horse ash wagons, 5 2-horse garbage.
Niagara Falls	60,000	...	Garbage, ashes, rubbish.	Motor trucks and horse drawn vehicles.
Ossining	12,000	6 sq. mi.	Garbage, rubbish.	2 garbage wagons, 3 ash wagons.
Rockville Center	9,000	4 sq. mi.	Household mat. only.	Horse-drawn vehicles.
Saratoga	13,000	30	Garbage, ashes.	Private.
Tarrytown	6,000	...	No separation.	.....
Utica	100,000	18 sq. mi.	Garbage, ashes.	.....
Watervliet	17,000	2 sq. mi.	No separation.	.....
North Carolina:				
Durham	30,000	3.9 sq. mi.	.....	4 ash carts, 3 rubbish trucks, 3 garbage carts, 9 garbage wagons.
Elizabeth City	10,000	25 mi.	Garbage, rubbish.	1 garbage truck, 4 rubbish carts.
Fayetteville	10,000	2 sq. mi.	.....	Wagons, carts and trucks.
Goldsboro	.....	...	Garbage, ashes, rubbish.	6 horse carts.
Greensboro	21,225	4	Ashes, all other refuse.	Garbage—2 carts, 4 wagons, 6 trucks. Ashes—4 wagons; rubbish—6 carts, 4 wagons.
Henderson	8,000	1 mi. from cen.	Garbage, ashes, rubbish.	.....
Wilmington	40,000	...	Garbage, rubbish.	3 garbage carts, 2 rubbish trucks, 5 rubbish carts, 1 ash truck. 3 auto trucks.
North Dakota:				
Jamestown	.....	...	.....	.....
Ohio:				
Akron	165,000	25 sq. mi.	Garbage only.	2 garbage wagons, 6 rubbish trucks,
Ashtabula	10,000	10 mi.	Garbage, rubbish.	4 rubbish wagons.
Bellefontaine	10,000	4 sq. mi.	.....	.....
Bucyrus	900	...	Garbage.	2 h. d. wagons, 1 tractor.
Chillicothe	16,000	12 mi.	.....	.....
Cincinnati	401,247	71 sq. mi.	Garbage, ashes, rubbish.	15 dirt wagons, 100 ash wagons, 6 ash carts.
Circleville	7,000	25 mi.	General.	.....
Dayton	152,000	16 sq. mi.	Garbage, ashes and rubbish.	16 wagons.
Fremont	14,153	2 sq. mi.	Rubbish.	.....
Portsmouth	40,000	10.81 sq. mi.	Garbage, ashes and rubbish.	10 garbage wagons.
Urbana	8,600	3½ sq. mi.	Garbage.	.....
Oklahoma:				
Ada	8,000	2 sq. mi.	Garbage, cans, bones and sticks.	Wagons.
Enid	10,000	8 mi.	Garbage, ashes and rubbish.	6 h. d. wagons.
Oregon:				
La Grande	7,000	3½ sq. mi.	Garbage, rubbish.	.....
Pennsylvania:				
Ashland	7,000	...	Ashes.	.....
Beaver Falls	15,000	2	Garbage wrapped in paper.	1 cart, 1 wagon.
Carlisle	15,000	1,400 acres	Garbage contr., a. & r. private.	.....
Dormont	8,500	1 sq. mi.	Garbage.	.....
Easton	34,000	3.3	Combustible, incombustible.	1 truck, 5 wagons.
Freeland	.....	½ sq. mi.	Private by individual.	Closed wagons.
Greenville	8,500	...	Garbage, all other refuse.	Sideboard wagons.
Kittaning	8,000	6 mi.	Garbage.	1 garbage wagon.
Lewistown	10,000	2 sq. mi.	Garbage and ashes.	Horses and wagons.
Meadville	15,000	1,351 acres	Garbage, rubbish.	.....
No. Braddock	10,000	900 acres	Garbage, rubbish.	.....
Pittston	10,000	4	Garbage, all other refuse.	1 garbage truck, 1 dump wagon.
Rankin	7,506	275 acres	Garbage, ashes, tin cans.	.....
Summit Hill	Ap. 6,000	7 mi.	Ashes, garbage.	.....
Williamsport	.....	...	Waste.	1 Elgin motor sweeper.
Rhode Island:				
Newport	32,589	...	Refuse.	5 carts.
Westerly	160,000	2 sq. mi.	Street sweepings.	.....
South Carolina:				
Chester	6,000	...	Rubbish.	Street flusher, brooms, push carts.
Spartanburg	25,000	3 mi.	All inflammable material.	.....
Tennessee:				
Memphis	163,000	25 3/10 mi.	Garbage, ashes and rubbish.	8 trucks, 76 carts.
Morristown	7,000	3 sq. mi.	No classification.	Same as for street cleaning.
Texas:				
Beaumont	50,000	10 sq. mi.	No classification.	.....
Dallas	175,000	25 sq. mi.	No classification.	.....
Navasota	5,000	2 sq. mi.	No classification.	.....

REFUSE COLLECTION—Continued

City	Population served	Area served,	Classification of refuse collected.	Equipment used for each class.
Utah:				
Brigham	Bus.	½ mi.	Ashes and cans.	.....
Vermont:				
Bennington	.....	18 mi.	Cans.	.....
Burlington	22,000	2 sq. mi.	Garbage.	1 H. D. water-eight garbage wagons.
Virginia				
Bristol	8,000	3 sq. mi.	Rubbish.	.....
Danville	.....	4½ sq. mi.	No separation.	.....
Lynchburg	3,500	4 sq. mi.	Garbage, ashes.	7 garbage wagons, 4 Troy ash wagons.
Newport News	35,000	4.55 sq. mi.	No separation.	.....
Petersburg	33,000	6 sq. mi.	Ashes and trash.	H. D. dump wagons.
Roanoke	60,000	9½ sq. mi.	Ashes, garbage and rubbish.	3 1½-cu. yd. wagons, 2 4-cu. yd. garbage trucks, 5 4-cu. yd. ash wagons.
Washington:				
Walla Walla	15,503	3.8 sq. mi.	Garbage, rubbish.	.....
West Virginia:				
Clarksburg	30,000	5 sq. mi.	Dry and wet refuse.	2 trucks.
Huntington	60,000	...	No separation.	.....
Wisconsin:				
Ashland	11,500	...	.....	.....
Menasha	1,800	3 sq. mi.	No separation.	.....
Green Bay	.....	...	Garbage, ashes.	Ford dump body truck, 6 teams.
Racine	75,000	8 sq. mi.	Garbage, ashes, rubbish.	Truck and trailer.
Sheboygan	31,000	3,000 acres	Garbage, ashes, rubbish.	Truck.
Wisconsin Rapids.	7,000	7 sq. mi.	Combined.	Garbage wagons.
Wyoming:				
Cheyenne	14,000	1 sq. mi.	No separation.	.....

(*Continued from page* 271)

first, that in which he furnishes his own garbage can and collections are made by wagons or trucks at least twice weekly or in most cases more frequently; or, second, by paying a fee of $5.00 yearly for one can and $3.00 for each additional can he secures a service by which all cans are furnished by the city and collections are made every second day, a clean, sterilized can being left and the full one removed. The costs of the first service are borne entirely by a special tax. The general collections are made with one-horse wagons and one Ford truck. The special collections are made by two trucks equipped with special bodies for carrying the cans. Complete records of cost are not available, but those at hand indicate that garbage was collected and disposed of last year (being burned in a municipal incinerator) at a cost of about $2.50 per yard, the average haul being about 2½ miles.

About 50 per cent of the ashes are dumped on the ground, either near or in the alley, by the householder and shovelled into the wagons by the collectors. The ashes are used largely for grading and surfacing unimproved streets.

BROCKTON, MASSACHUSETTS

In Brockton, Massachusetts, rubbish and ashes are collected by the Health Department, the barrels being placed at the street-line. However, the Department will remove the material from the cellar at $1.50 per load of about ten barrels, or for $1.00 a load from the yard. Collections are made by one truck, four double teams and four single teams. The appropriations and revenues for the past five years have been as follows:

	Appropriations	Revenues
1917	$20,790	$2,700
1918	22,773	2,522
1919	30,960	3,618
1920	41,101	6,588
1921	37,664	6,349

The rates of collection were doubled in 1920, which accounts for the sudden jump.

WALTHAM, MASSACHUSETTS

In Waltham, Massachusetts, the city, prior to April, 1922, had its garbage collected by contract, but at that date began collecting by municipal labor and hauling to a central location, where it is sold to farmers. City Engineer Beal gives it as his opinion that "the contract method of garbage collection in a city the size of Waltham is unsatisfactory at best. We have tried this method for the past five years and the results have given general dissatisfaction. For two years the public has clamored for the return to collection by the city, which was in vogue for years previous to 1917 and gave general satisfaction, although far more expensive than the contract method."

ALMA, MICHIGAN

Alma, Michigan, has contracted for garbage collection with the owner of a hog farm, the payment being on the rather unusual basis of 3 cents for each collection of garbage, the garbage being removed twice a week from the residence section and daily in the business section. City Manager Reynolds reports that the service received has been very good and quite satisfactory.

OWOSSO, MICHIGAN

In Owosso, Michigan, a city of about 14,000, the garbage is collected by a private concern under city ordinance, the collector using the garbage for hog feed. An unusual feature is that the collector furnishes the garbage cans. He collects every other day and the householder pays $1.00 per month for the service.

AUSTIN, MINNESOTA

In Austin, Minnesota, the combined refuse is collected by a private contractor who is paid, partly by the city and partly by the householder, $1,620 per year. From 300 to 500 householders pay 50 cents per month for each residence and $1.50 for a business house, and the city makes up the deficit, which ordinarily runs from $700 to $1,000 per year.

(*To be continued*)

Some Refuse Incinerators

Operating details of twenty incinerators as reported from an investigation by the city manager of Alameda, California.

Some months ago the city manager of Alameda, California, Clifton E. Hickok, was requested by the city council of that city to inspect the refuse incinerators in the western and middle western parts of the country, and visited twenty incinerators in California, Oregon, Washington, Vancouver, Minnesota, Missouri, Oklahoma, Texas and Louisiana. The information thus obtained was presented by him in a paper before the League of California Municipalities from which the following information has been derived, that part being tabulated which could readily be treated in this way.

This table shows that nine of the incinerators visited were of the English type, four of the Decarie type and seven of the Dutch oven type. Those lying outside of California were visited in October and November of last year, and the information given is brought up to that date only.

Based on information obtained by this visit and otherwise, Mr. Hickok makes some general remarks on incinerator practice, with special reference to the adoption of incineration for the city of Alameda. This city has a population of 30,000, which is very largely residential, and produces practically no industrial, trade or stable wastes. From observation and measurements he estimated that there was produced on the average 5 tons of garbage and 22 tons of rubbish per day, 19 tons of the rubbish being combustible and three tons non-combustible. Of these 27 tons of refuse, 25 tons was reaching the dumps between 10:00 a. m. and noon, and the other two tons between 4 p. m. and 5 p. m.

He gives as the major elements entering into the success of an incinerator: 1. First cost. 2. Operating cost. 3. Successful burning capacity. 4. Receiving capacity. 5. Maintained temperature of at least 1250 degrees F. 6. Simplicity of operation as regards charging, stoking and removal of clinkers and ash. 7. Comparative freedom from obnoxious odors and smoke. 8. Minimum fuel requirements. 9. Absence of complicated mechanical contrivances.

He divides incinerators into three types — the English type, the steel furnace or water-jacket type and the Dutch oven type.

The tabulated data obtained on his inspection shows the cost of construction varying from approximately $200 per ton per day capacity to $1,500. The cost per ton for burning refuse varies almost as widely—from 47¼c. per ton burned to $3.19. In a number of instances the high cost of burning was found to be accountable for by local conditions. The $3.19 in New Orleans, which was paid almost entirely for labor, was unnecessarily high because a needless number of men were employed and also because the plant was too elaborate mechanically. The plant showing the lowest cost was one of the two largest in the list. Another plant of the same make and two-thirds the capacity was costing nearly five times as much per ton, but here again the staff was unnecessarily large.

No fuel was used in any of the English type of furnace, and one of the Dutch oven type also was operated without fuel, but all of the others required more or less additional fuel, oil being used in a number of the California plants.

A number of the plants were located where any nuisance given off would be seriously objectionable. For instance, in Pasadena the plant is located in the heart of the city on a prominent boulevard, with industries and residences on all sides and with one of the state's noted hotels within 1500 feet, but it is said that no complaints have been received. The New Orleans plant is located on a street in a modest residence district, with houses within 100 feet of it. That at Beaumont, Texas, is located within two blocks of the main business district and immediately adjacent to a police station, and there are homes of white people directly across the street and factories and warehouses close by.

Boilers are reported as being installed in connection with four of the plants, two of these being plants of the English type and two of the Decarie type. Mr. Hickok reports that the boiler in Berkeley, California, "has not justified its installation." In Portland, Oregon, there are two 100-H. P. boilers "for the operation of fans, for heating and hot water," but apparently for nothing else. The boiler at Santa Cruz "proved unsuccessful and its use was abandoned." In Minneapolis a 330-H. P. boiler was located between two furnaces, and is also fired independently. The steam is used to operate three generating units in an adjoining engine room, the current from which is utilized for street-lighting, etc. The amount of steam that is generated by the burning of the garbage is negligible. Apparently none of the other plants made any effort to utilize the heat for raising steam, except in Sacramento, where the steam from the Decarie plant is used for providing forced draft.

As to the satisfactoriness, most of them seem to have met his requirements in this respect. Exceptions noted were the old Thackeray furnace in San Francisco, where he found much unconsumed material in the clinker, and the same condition at New Orleans and Vallejo; a considerable quantity of smoke from the plants at Minneapolis and Baton Rouge, and considerable odor at the latter city and at Vallejo. Each of these two last named were reported, however, to be operated carelessly.

Incidental to the incinerator, it was learned that certain other plans had been tried in a few of the cities. For instance, Pasadena had tried grinding a part of the garbage for chicken feed, but this had proved unsuccessful. At the Thackeray furnace in San Francisco there had been a foundry for making sash weights from tin cans and other metals, but this also had not been a success.

He includes in his list the plant built for San Francisco in 1913, which the city refused to accept and which has never been used, and the plant built in Seattle in 1907, but which went out of commission in 1915, and the metal parts were sold during the war, when metal prices were high.

OPERATING DETAILS OF INCINERATORS AS GIVEN BY CITY MANAGER OF ALAMEDA

City	Make of Plant	Year Built	Cost	Rated Capacity	Amount Actually Burned	Number of Operators	Cost per Day for Labor	Cost per Day for Fuel	Average Cost per ton Burned	Boiler	Remarks
English Type											
San Jose, Cal..	Fred P. Smith	1913	$30,000	3 1/3 T. per hr.	12 T. in 8 hr.	2	$9.00	None	$0.75		Oil burner installed, but not necessary. No material odor or smoke.
Pasadena, Cal...	Fred P. Smith	1912	42,251	83 T. per hr.	5 T. per day§	1 1/2	7.65	None	1.53		Grinding part of garbage for chicken feed unsuccessful. In heart of city on boulevard. No complaints. Garbage fed to hogs.
Portland, Ore...	Fred P. Smith	1911	99,900	6 1/4 T. per hr.	157 T. per day	18	69.00	No fuel	.47¼	Two 100 h.p.	No separation of material except ashes and cans.
Vancouver, B. C.	Fred P. Smith	1911	67,491	4 1/6 T. per hr.	16 T. in 8 hr.	6	31.30	None	2.17		Staff unnecessarily large.
Vancouver, B. C.	Heenan-Froude	1907			Closed 1916		Excessive				
Berkeley, Cal...	Sterling destructor	1913	65,000	2 T. per hr.	37 1/2 T. in 16 hr.	7	40.00	None	1.07 (labor only)	Water tube	Mechanical charging and clinker removing. Forced draft. Constant stoking. Boiler "has not justified installation."
San Francisco...	Thackeray	1897	400,000†	25 T. per hr.	400 T. per day	51		No fuel	1.00		Badly deteriorated. Sash weight foundry for utilizing tin cans, etc., a failure.
San Francisco ..	Heenan-Froude	1913	155,000	5 T. per hr.	Not operated						City refused to accept claimed specifications as to odor, smoke and dust not met.
Seattle, Wash...	Meldrum	1907		Not operated since 1915.							Sold for old metal during war.
Steel Furnace											
Sacramento, Cal.	Decarie	1907	62,000	3 1/3 T. per hr.	66 T. in 16 hr.	8	47.16	$1.08	.52		Steam used for forced draught.
Santa Cruz, Cal.	Briggs (similar to Decarie)	1915	7,000	1 1/4 T. per hr.	3/4 T. per hr.	1	4.50	3.50	1.33	Unsuccessful; not used	Oil and shavings for fuel. Mixed refuse.
Minneapolis, Minn.	Decarie	1901		6 2/3 T. per hr.	56.3 T. per day	15	79.00	13.00	1.63	One 330 h.p	
New Orleans, La.	Decarie	1916	35,000	1 1/2 T. per hr.	8 T. in 8 hr.	6	25.20	.24	3.19		Steam from incinerator negligible.
Dutch Oven											
Vallejo, Cal....	Collins & Pellet	1919	12,000	1.5 T per hr.	25 T. in 24 hr.	4	20.00	1.40	.85		Houses within 100 ft.; little complaint. Too elaborate mechanically.
Presidio, S. F...	Lea and Nye	1914	4,000*	2/3 T. per hr.	2 T. in 8 hr.	1	....	....	2.56		Oil burner. Very short stack. Carelessly operated; considerable odor.
Sedalia, Mo.....	Nye Odorless	1921	15,000	1 T. per hr.	10T. per day	1	3.84	2.35	.62		Oil burner. Very short stack. Nothing but garbage burned.
Tulsa, Okla....	Nye Odorless	1921	25,000*	4 T. per hr.	? Just built						Destroyed more than a horse a day.
Waxahachie, Texas	Nye Odorless	1921	8,000	1/2 T. per hr.	4 T. in 8 hr.	1	2.32	.08	.60		No separation of garbage and refuse.
Beaumont, Tex..	Nye Odorless	1921	10,000	1 T. per hr.	14 T. in 8 hr.	3	7.20	.69	56		Adjoins police station.
Baton Rouge, La.	Nye Odorless	1914		1 T. per hr.	6 T. in 8 hr.	2	4.00	None	.67		Plants (2) neglected; smoke and odor.

*Furnace alone. †Paid by city in 1900. §Rubbish only.

NEWS OF THE SOCIETIES

CALENDAR

Dec. 26-30—AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE. Meeting, Massachusetts Institute of Technology, Cambridge, Mass.

Jan. 9—NEW ENGLAND WATER WORKS ASSOCIATION. Annual meeting, Boston, Mass. Secretary, Frank J. Gifford, Tremont Temple, Boston.

Jan. 11-12—AMERICAN ENGINEERING COUNCIL. Annual meeting at new headquarters of F. A. E. S., 24 Jackson Place, Washington, D. C. Secretary, L. W. Wallace, 24 Jackson Place, Washington, D. C.

Jan. 11-12 — FEDERATED AMERICAN ENGINEERING SOCIETIES. Annual meeting, Washington, D. C.

Jan. 15-17—NATIONAL CRUSHED STONE ASSOCIATION. Annual convention at Chicago. Secretary, A. P. Sandles.

Jan. 15-18 — AMERICAN ROAD BUILDERS ASSOCIATION. Annual convention, Chicago.

Jan. 17-18—AMERICAN SOCIETY OF CIVIL ENGINEERS. Annual meeting, 29 West 39th Street, New York City. Secretary, John H. Dunlap.

Jan. 22-26—AMERICAN CONCRETE INSTITUTE. Annual convention, Cincinnati.

Jan. 23-25—ILLINOIS SOCIETY OF ENGINEERS. Annual meeting at Peoria. Secretary, E. E. R. Tratman, Wheaton, Ill.

Jan. 23-26—IOWA ENGINEERING SOCIETY. Annual Meeting in Des Moines. Secretary, Lloyd A. Canfield, 406 Flynn Building, Des Moines.

Jan. 24—BOSTON SOCIETY OF CIVIL ENGINEERS. Meeting, Boston, Mass. Secretary, J. B. Babcock, Tremont Temple, Boston.

Jan. 25-26 — SOUTH ATLANTIC COASTAL HIGHWAY ASSOCIATION. Meeting at Charleston, S. C. Secretary, A. V. Snell, Jacksonville, Fla.

Jan. 27—NORTHEASTERN SECTION, AMERICAN SOCIETY OF CIVIL ENGINEERS. Annual meeting, Boston, Mass.

Jan. 30-Feb. 3—ASSOCIATED GENERAL CONTRACTORS OF AMERICA. Annual meeting, Los Angeles, Calif.

May 7-9—AMERICAN ASSOCIATION OF ENGINEERS. Ninth annual convention, Norfolk, Va. Secretary, C. E. Drayer, Chicago.

May 21-25 — AMERICAN WATER WORKS ASSOCIATION. Annual convention, Statler Hotel, Detroit, Mich. Secretary, John M. Diven, 152 West 71st Street, New York City.

Nov. 12-16—AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS. Annual convention, Memphis, Tenn. Secretary, Charles Carroll Brown, St. Petersburg, Fla.

GOOD ROADS CONGRESS, CONVENTION AND SHOW

The American Road Builders' Association will hold its Thirteenth American Good Roads Congress, Twentieth Annual Convention and Fourteenth National Good Roads Show and Highway Industries Exhibit January 15, 16, 17, 18 and 19, 1923, in Chicago. The Coliseum and adjoining buildings, in which the shows in 1921 and 1922 were held, have been leased again for this purpose. At the drawing for space held November 17, practically every foot of the 50,000 square feet of exhibition space in the Coliseum and Annex was taken.

The next congress and convention will be held at the Congress Hotel, instead of the Coliseum as heretofore. It is believed that this arrangement will insure a better attendance at each session, while the show will continue without interruption. The new arrangement, too, will eliminate the noises that heretofore have been so disturbing to the speakers and delegates.

The old idea of a session on bituminous roads, another on concrete, a third on brick, and so on, has been entirely abandoned, and controversial subjects on which there is much need for light will be featured. Men who are leaders in solving the complex problems confronting the industry will present these subjects; other men of equal experience and standing will lead the discussions. Some of the papers will be printed well in advance and circulated, so as to permit of thorough study in preparation for an exhaustive discussion on the floor.

From the official program here presented in full it will be noted that results of the latest research investigations by the United States Bureau of Public Roads, the State Highway Department of Illinois and other organizations and institutions conducting research work are stressed for detailed discussion. Highway finance and highway transportation will receive in full the serious consideration they merit, as well as the future of Federal aid to the states and other national and state road problems, both in administration, construction and maintenance. No session will be held on Wednesday afternoon, in order that all delegates in attendance may be entirely free to visit the Good Roads Show at the Coliseum. The program for the congress will be as follows:

Official Program

Opening Session

Tuesday, January 16, 10 A. M.

Chairman—Thomas J. Wasser, State Highway Engineer of New Jersey, President, American Road Builders' Association.

President's address.

Greeting and Inspiration—James H. MacDonald, Treasurer, American Road Builders' Association.

Continued Highway Expenditures Required to Meet Traffic Demands of the Future—Thomas H. MacDonald, Chief, United States Bureau of Public Roads, Washington, D. C.

Progressive Construction of Highways—(a) Practice in North Carolina, C. M. Upham, State Highway Engineer, North Carolina; (b) Practice in Iowa, C. Coykendall, Assistant Chief Engineer, Iowa Highway Commission.

The Obligation of the State Highway Department to Keep the Public "Sold" on Highways—By H. E. Hilts, Acting Chief Engineer, Pennsylvania State Highway Department, Harrisburg, Pa.

Design

Tuesday, January 16, 2:30 P. M.

Chairman—Thomas H. MacDonald, Chief, United States Bureau Public Roads.

What Test Road Results Have Taught Us—(a) Bates Test Road, Clifford Older, State Highway Engineer of Illinois, Springfield, Ill.; (b) Pittsburgh Test Road, Lloyd Aldrich, Consulting Engineer, San Francisco, Cal.; (c) Arlington Tests, A. T. Goldbeck, Engineer of Tests, United States Bureau of Public Roads, Washington, D. C.

Development of Appartus for Field ing Engineer, Division of Highways, Testing of Roads—H. F. Clemmer, Test-Springfield, Ill.

Developments in the Use of Local Materials—Vernon M. Pierce, District Engineer, United States Bureau of Public Roads, Washington, D. C.

Designed Subgrade—C. M. Upham, State Highway Engineer, Raleigh, N. C.

Construction

Wednesday, January 17, 10 A. M.

Chairman—J. H. Cranford, President, Cranford Paving Company, Washington, D. C.

Haulage Methods in Highway Construction—Industrial Railways, A. J. Parrish, General Contractor, Paris, Ill.; Heavy Truck Haulage, Charles H. Fry, Charles H. Fry Construction Co., Erie, Pa.; Light Truck Haulage, A. E. Horst, Henry W. Horst Co., Rock Island, Ill.

How to Equip and Operate Local Gravel Pit or Produce Concrete Aggregate—H. E. Kuelling, Construction Engineer, Wisconsin Highway Commission, Madison, Wis.

How Much Time Is Lost in Delays in Highway Building?—H. K. Davis, Chief Inspector, Iowa Highway Commission, Ames, Iowa; Discussion, B. H. Piepmeier, State Highway Engineer of Missouri, Jefferson City, Mo.

What Road Building Work Can Be Done in Winter?—John H. Mullen, Chief Engineer, Minnesota Highway Department, St. Paul, Minn.

Maintenance

Thursday, January 18, 10 A. M.

Chairman—A. R. Hirst, State Highway Engineer, Madison, Wis.

Organization of Intensive Maintenance on a State Highway System in Eighteen Months—Frank Page, Chairman, North Carolina State Highway Commission, Raleigh, N. C.

Four Years' Experience with Patrol Maintenance in Wisconsin—J. T. Donaghey, Maintenance Engineer, Wisconsin Highway Commission, Madison, Wis.

Gravel Road Maintenance Practice in Michigan—L. H. Nielsen, Deputy State Highway Commissioner of Michigan, Lansing, Mich.

Blade Grader and Road Drag Earth-Road Maintenance in Iowa—W. H. Root, Maintenance Engineer, Iowa State Highway Commission, Ames, Iowa.

Salvage and Maintenance of Macadam Roads—W. A. Van Duzer, Assistant Maintenance Engineer, Pennsylvania Highway Commission, Harrisburg, Pa.; Discussion, A. W. Muir, Superintendent of Maintenance, New Jersey Highway Commission, Trenton, N. J.

Traffic

Thursday, January 18, 2:30 P. M.

Chairman—Thomas J. Wasser, State Highway Engineer, New Jersey.

Tourist Traffic as a Factor in Highway Development (Illustrated)—A. R. Hirst, State Highway Engineer of Wisconsin, Madison, Wis.

Changes Needed in Motor Vehicle Legislation and License Fees—J. N. Mackall, Commissioner of Roads, Baltimore, Md.; Discussion, Leon C. Herrick, Director of Highways and Public Works, Columbus, O.; Harry Meixell, Jr., New York, National Automobile Chamber of Commerce.

Election of officers:

Business meeting.

Finance and Miscellaneous

Friday, January 19, 10 A. M.

Chairman—Frank Page, Highway Commissioner of North Carolina.

Have Large Expenditures Changed the Public Attitude Toward Highway Development?—S. E. Bradt, former Superintendent of Highways of Illinois,

Co-operation Between State and County Highway Departments—L. C. Herrick, Director of Highways and Public Works, Columbus, Ohio.

How Individual Organizations Can Fit Their Work into the Broad Highway Research Program—W. K. Hatt, Director, Highway Research Committee, National Research Council, Washington, D. C.

THE GOOD ROADS SHOW

The exposition of labor-saving machinery, materials, methods and appliances will open at the Coliseum Monday, January 15, at 8 P. M., and will surpass in the number and variety of its exhibits the great exposition of last year. Many firms which heretofore have never exhibited at the National Good Roads Show have engaged space.

The exhibits will include every kind of practical road building machinery, materials, appliances and transportation equipment. They also will include many new inventions that have been developed during the past year and many improvements in existing lines which will be announced for the first time. Anyone who contemplates purchasing machinery, materials or appliances cannot afford to forego a personal inspection of the exhibits. It is the purpose of the American Road Builders' Association to make this show exceed in educational value all others heretofore. The show will be open at all times to any and every one interested in highway construction and the good roads movement in general.

An interesting feature of the show will be an exhibit by the United States Bureau of Public Roads, for which more than 2,000 square feet of space will be necessary, as well as complete exhibits dealing with road construction by several state highway departments and the Asphalt Association, the Portland Cement Association, the National Association of Paving Brick Manufacturers, the Associated Pennsylvania Highway Contractors and similar organizations that will demonstrate the latest methods evolved in laying the various types of pavements. The exhibit of the United States Bureau of Public Roads will be much more extensive and interesting than the elaborate display which attracted so much attention at the show last year. One of its most attractive features will be a large model showing the type of road the bureau is building in the national forests. The model will be twenty feet in length and will represent a section of highway in a typical mountain region. The road will be hung upon the face of precipitous cliffs high above the valley floor and at one point it will be conducted over a deep gorge by a handsome arch bridge. The beauty of the model will be enhanced by a large painting in oil so as to furnish a gorgeous background and add to the realism of the model. The painting and model will be ten feet high and when seen from a slight distance it will be impossible to detect the junction between them, so cleverly have the artists done their work.

Around the model as a center-piece will be grouped a display of illuminated colored photographs showing Federal aid roads in all parts of the country, together with interesting views of the experimental and research work done by the bureau. Small models of bridges and roads of various types in course of construction will be included in the exhibit, as well as a display of testing apparatus that will include a number of new devices developed by the bureau's engineers.

Progress in Federal aid road construction will be shown graphically by means of numerous charts. A large map will show what has been accomplished in extending the Federal aid highway system. The exhibit will also include a large assortment of specimen road materials, stereopticon lantern slides and motion pictures of actual road construction. The exhibit will be the most complete highway exhibit ever made by any government in the world.

ASSOCIATED GENERAL CONTRACTORS

The Fourth Annual Meeting of the Associated General Contractors of America will be held in Los Angeles January 30 to February 2. It will be devoted to a consideration of progress made in the joint conferences on standard contract forms, relations with state highway officials, construction equipment, and trade practices in the marble industry.

Other subjects discussed will be the work of the National Board of Jurisdictional Awards, the American Construction Council, and legislation affecting immigration and day labor work. Standard estimate sheets and bank statements for general contractors will be presented at the meeting. Special sessions will be devoted to problems of building, highway, railroad and public works contractors. A "Convention Special" will leave Chicago January 24, the day following the close of the Annual Road Show in that city, which will be joined by other groups at Omaha, Denver and Salt Lake City.

SOUTH ATLANTIC COASTAL HIGHWAY ASSOCIATION

This association will meet in Charlestown, S. C., January 25 and 26. The first session will be devoted to general statements in regard to highway and business matters. Thursday afternoon there will be group meetings to complete county organizations. Friday morning reports of state committeemen will be received and in the afternoon reports of general committees and a discussion of ways and means for completing unfinished portions of the road.

AMERICAN CONCRETE PIPE ASSOCIATION

The annual convention of this association will be held at the Sherman Hotel, Chicago, January 18 to 20. The secretary is N. W. Loving, 111 West Washington Street, Chicago.

AMERICAN CONCRETE INSTITUTE

The 1923 Convention of the American Concrete Institute will be held in Cincinnati, at the Hotel Sinton, January 22 to 25. The program includes a session on Monday devoted to "Concrete Products Manufacture" and one on "Concrete Roads"; on Tuesday a second session on "Concrete Products," one on "Field Problems" and one on "Concrete Houses and Architectural Concrete."

AMERICAN SOCIETY OF CIVIL ENGINEERS

The 70th Annual Meeting of this society will be held at the headquarters on January 17, 18 and 19. Annual reports will be read, officers elected, reports of special merit read, medals and prizes awarded, honorary membership conferred, and other business transacted.

NORTH CAROLINA SECTION, AMERICAN WATERWORKS ASSOCIATION

The second annual meeting of the North Carolina Section of the American Water Works Association was held at Gastonia, N. C., November 14-16. A novel feature of the gathering was the holding of the regular meetings on the lower floor of the new two million gallon water filteration plant of the city. This plant was recently completed and is very up to date in its appliances, affording an opportunity for inspection to the many visiting superintendents.

The registration was one hundred and twenty, which was by far the largest attendance ever had at any meeting of water works men in the state. Of those present about 47 were superintendents, filter plant operators, or were otherwise actively engaged in water supply operation. All of the principal consulting engineers of the state engaged in the design of water supplies and purification plants were present, and a goodly number of manufacturers' representatives were engaged in describing the interesting exhibits.

The meetings were all unusually well attended, the papers covering a wide field so that nearly every man present found one or more papers dealing with subjects of especial interest to him.

In addition to inspecting the details of the new filtration plant under the guidance of the superintendent, C. E. Rhyne, those attending the meetings were taken in cars to the new activated sludge sew-

age treatment plant, designed by William Piatt of Durham. This plant makes use of a modification of the Maclachlan process of sludge dewatering by use of sulphur dioxide gas generated at the plant. This modification was devised by William Piatt and is working most satisfactorily, the sludge, after being treated and pressed, appearing as an inoffensive sludge cake, which is used for fertilizer.

C. W. Grantham, city manager of Goldsboro, urged the Section to take some steps toward obtaining a state plumbing code. The secretary, Professor Saville, described briefly the work done by the subcommittee on plumbing of the United States Department of Commerce and the outline for a model plumbing law which it was soon to issue. It was suggested that a committee of the Section be appointed to consider the question of a state plumbing law and report its recommendations to the next annual meeting.

A spirited discussion took place with regard to charges for private fire services. Sherwood Brockwell, deputy state insurance commissioner, presented the insurance side of the case, while city managers Grantham of Goldsboro and Alexander of Gastonia spoke from the point of view of the municipality.

The chief discussions were brought out in connection with papers by J. O. Craig on "Water Rates," by W. McK. Moffitt and J. S. Bennett on "Universal Pipe," by M. N. Boyles on "Experience with Wood Stave Pipe," and by W. D. Cates on "Water Works Superintendent' Responsibility for Fire Fighting." Mr. Cates mentioned that in the recent serious fire in Atlanta, the threads on hydrants had been found so badly worn by use of hydrants for street flushing as to seriously interfere with their use for fire service.

A complimentary banquet was given by the city on the second evening, following a get-together dinner, held on the first evening. The Hill membership cup, which is given annually to that section of the A. W. W. A. having the greatest per cent. increase in membership, was won by the North Carolina Section last year, and was displayed prominently at the dinners. The Section was organized in September, 1921, with 23 members, and now has about 40. The membership is continuing to increase, and the Section expects to be able to retain the cup for at least another year.

Papers of particular interest, other than those mentioned above, were "Drilling and Care of Deep Wells," by J. C. Godfrey; "Design and Use of Centrifugal Pumps," by T. C. Heyward; "Use of Oxy-acetylene Torch in Water Works Practice," by J. C. Michie; "Use of Deep Well Water to Save Alkalinity," J. C. Womble; "The Laboratory Control of Filtration," by G. D. Norcom; "Operation of a Small Filter Plant," by R. J. Ward of Zebulon; "The Importance of Filter Sand and Gravel in Filtration Plants," by A. O. True; "Operation of Mechanical Filters with Value of Simple Laboratory Tests," by W. M. Turner; "The Lexington, N. C. Filtration Plant," by W. L. Jones; "Operation of Chlorine Control Apparatus," by P. J. Dishner; "Economical Control of Chemical Dosage in Filtration Plants," by R. A. Maddock of Charlotte; "The Operation and Care of Centrifugal Pumps," by R. M. Alexander, and "Combustion of Coal in Boiler Furnaces," by A. McK. Maffitt.

A noteworthy feature of the meeting, of especial interest to filtration plant operators was the presentation of the paper by E. J. Theriault of the U. S. P. H. S. on "Use of Hydrogen Ion Determinations." Dr. Theriault gave an interesting and non-technical discussion on what hydrogen ion determinations mean to the water works operator, and the lines along which studies are being prosecuted to make this determination of greater practical value. Following Dr. Theriault's address, Mr. Cattlett of the State Board of Health and Mr. Norcom of Wilmington described investigations being conducted in this state on hydrogen ion determinations. Whereas, Dr. Theriault had found that a Ph. value of 5.5 gave generally optimum conditions for precipitation of a floc from aluminum sulphate, in this state the Ph. value for good precipitation ranged from 4.2 at Wilmington to 6.6 at other places, depending upon the local characteristics of the water being treated.

The success of the meetings was due largely to the untiring efforts of the enterprising City Manager of Gastonia, W. J. Alexander, who did not spare himself in putting every facility of his office at the disposal of the Section, as well as providing the use of the new filter plant for use at meetings and arranging for the complimentary dinner given those attending.

The officers elected for the ensuing year are: President, Ernest B. Bain, superintendent of water works, Raleigh; Vice-President, J. O. Craig, superintendent of water works, Salisbury; Secretary and Treasurer, Thorndike Saville, Professor of Hydraulic and Sanitary Engineering, University of North Carolina, Chapel Hill, N. C. The Section voted to hold its next annual meeting at New Bern, in the eastern part of the state.

PERSONALS

Cooper, Daniel C., formerly city engineer of Elkins, W. Va., has been appointed construction superintendent by the U. S. Gypsum Company at Oakfield, N. Y.

McCullough, E. W., of Indianapolis, has been appointed engineer for the designing and construction of a garbage disposal plant for that city.

Browning, Dewitt, has resigned as city engineer of Long Beach, Cal.

Richards, Charles Russ, formerly dean of the College of Engineering of the University of Illinois, was installed as president of Lehigh University on October 14.

White, H. Collins, formerly superintendent of the Dayton, Ohio, Water Works, has been employed in an executive capacity by the Linden Chemical Company of Dayton.

Mantel, L. W. B., of Uvalde, Texas, has been appointed city engineer at San Angelo.

Hinckley, G. S., city engineer of Redlands, Cal., is in charge of the flood control work at the headquarters of the Santa Ana River, undertaken by San Bernardino, Riverside and Orange Counties.

Keller, Henry A., formerly resident engineer with the North Carolina State Highway Department, has been appointed district highway engineer in Albermarle County, Virginia.

Lane, Joseph T., has resigned as commissioner of public works of Syracuse, N. Y. He has been succeeded by Duncan W. Peck.

Blair, John E., has been appointed city engineer of Mineola, Tex.

Reed, Howard S., recently associated with Sheldon K. Baker, of Phoenix, Ariz., has been appointed city engineer of that city.

BOOK REVIEW

"MOSQUITO ERADICATION," by W. E. Hardenburg. 246 pages, 146 illustrations. Published by McGraw-Hill Book Company. This is believed to be the only book, other than reports of federal, state and local commissions and officials, that deals exclusively with mosquito eradication, and is certainly most complete. The author states that he himself knows of no compreliensive book on the subject except one by LaPrince and Orenstein on "Mosquito Control in Panama." The author has had considerable experience with the U. S. Public Health Service, and has drawn upon the reports issued by this and other federal departments for much of his material.

The chapters deal with: "The Toll of the Mosquito," "Some Disease-Bearing American Mosquitoes," "Development of Control Measures," "Initiating the Campaign," "Administrative Aspects of the Campaign," "Inland Drainage," "Salt Marsh Drainage," "Oiling," "Fish Control," "Screening," "Other Measures and Expedients and Points Requiring Investigation," "Rural Mosquito and Malaria Control," and four appendices, one tabulating the points of differentiation between the different species of mosquitoes; another giving an anti-mosquito ordinance; a third giving a suggested anti-mosquito leaflet for educational work, and the fourth being a bibliography of the subject.

A special feature of excellence is the practical nature of the instructions for carrying out the various work, both those of an engineering nature and those for oiling, fish control, etc.

New Appliances

Describing New Machinery, Apparatus, Materials and Methods and Recent Interesting Installations

THE AUSTIN PUP

Specifications of the Illinois State Highway Department call for a 3-ton power roller, and to meet this the Austin-Western Road Machinery Company is ready to furnish a small 3-wheel road roller weighing only 3 tons which is called the "Austin Pup." This is believed to be the first 3-wheel power roller weighing less than 7 tons. In addition to preparing the subgrade by bringing it to true surface, it will pull a wheel or drag scraper or fresno or a small road machine or plow or anything else that a small tractor will do. It can also be used for rolling gravel, stone or earth roads, drives in parks and cemeteries, etc.

By combining the essential features of a Fordson tractor with the other features of the Austin gas roller the company is able to sell the Austin Pup at a much lower price than would be possible in any other way. In addition, the purchaser can obtain repair parts of the tractor from any Ford agent.

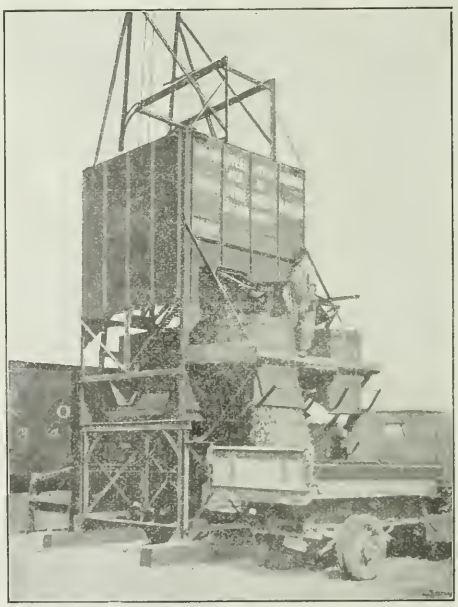
The total length is 12 feet 6 inches, total width 5 feet, each rear roll is 42 inches diameter and 18-inch face and front roll 28 inches diameter and 15½-inch face. The weight on the rear rolls is 4,120 lbs. and on the front rolls 1,880 lbs. The road speeds are 1.48 miles per hour low and 2.73 miles high, with 2.61 miles reverse.

THE EUREKA SNOW PLOW

A special double-strength plow known as "The Eureka" has been designed and is being built for use with the crawler type of tractor by the W. M. Toy Company. An elevated nose in front of the plow causes it to pass over stones or other hidden obstructions without lessening the speed of the tractor and independent of the attention of the driver. It is claimed to be securely built and braced so that it will not jack-knife. The forward end of the plow is carried on an I-beam runner that curves upward in front of the angle to lift it over obstructions, and the rear ends of the wings are also carried on runners curved at both ends to permit the plow to be drawn backwards when desired. These runners carry the weight of the plow at all times. The plow is pushed by driving bars composed of two 3-inch channels on each side of the tractor, which are pivoted to the rear of the plow and to a compensating bar pivoted centrally with the rear axle, which insures an equal distribution of power to the driving bars regardless of the angle of plow or tractor. The wings are 24 inches high and 7 feet long and the spread of the plow is 9 feet. The weight is 700 lbs., ready for shipment.

NEW FORM OF EXPANSION JOINT

A new form of the Carey Elastite Expansion Joint is being furnished by the Philip Carey Company and has been accepted by the Illinois State Highway Department and approved by that of the State of Michigan. It is known as a tongue-and-groove expansion joint and was developed to fill the specific need of a longitudinal joint for concrete roads that would prevent spalling and crushing of concrete at the joint due to slab movement, maintain constantly a watertight seal and, by interlocking action, hold adjacent slabs to uniform surface alignment, making it impossible for one slab to settle below or rise above its neighbor. The material used is the same as in the joints heretofore manufactured by this company.



GALION BATCH MEASURING HOPPER.
Operator releasing trip lever which permits swinging side-door to open and dump the measured quantity of 20 cu. ft. of crushed stone into truck below.

BATCH MEASURING HOPPER

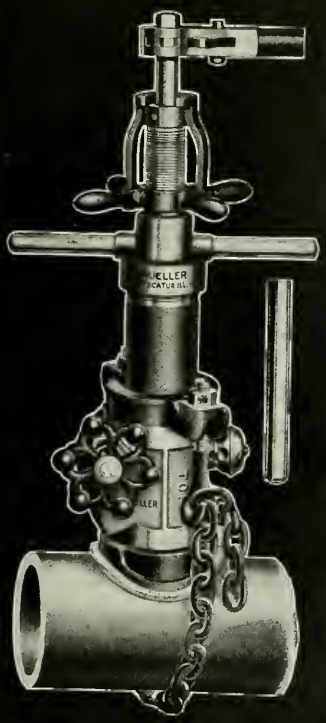
A batch-measuring hopper for accurately measuring crushed stone, sand, gravel or similar material being discharged from the bin into trucks or wagons is manufactured by the Galion Iron Works and Manufacturing Company. The hoppers can be attached to the bin of any Galion car unloader, gravel screening plant, or to any portable or stationary bin. They provide for the contractor a simple and efficient method of quickly and accurately measuring aggregate. They are operated by an attendant on a convenient platform, who has ample time for refilling the empty hoppers while waiting for a loaded truck to withdraw and an empty one to take its place. It is claimed that with the use of these hoppers and sufficient trucks, a car of aggregate may be unloaded and accurately measured batches dumped into the trucks and hauled away in two hours or less time, depending on the number and speed of the trucks.

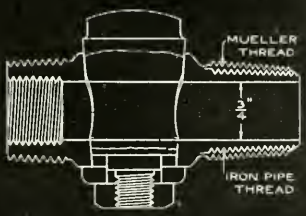
The hopper is made of heavy sheet steel throughout, no wood entering into the construction. It is regularly made in sizes of 10 or 20 cubic feet capacity, but other sizes will be made to suit requirements. The chute is provided with a semi-circular steel hinged gate, while the bottom of the hopper slopes at an acute angle which causes it to empty quickly as soon as the swinging dumping door, which constitutes one side of the hopper, has been released.

The illustration shows the operator releasing the trip lever of the hopper door and discharging 20 cubic feet of crushed stone into the truck below.

TYPE 15 AIR COMPRESSORS

A new line of small, vertical, belt-driven air compressors, known as "Type 15" is announced by the Ingersoll-Rand





The Value of the Mueller Thread

A tap made with the *MUELLER* Thread sinks a cone-shaped hole in the water main, slightly narrower on the inside than on the outside surface of the main.

A Corporation Cock with the *MUELLER* Thread screws into this hole *like a wedge* — the more you screw it, the tighter it fits. That's why the patented

Mueller "B" Tapping Machine

does such effective work — tapping and inserting corporation cocks under pressure, from ⅜″ to 1″ — and tapping only from ⅜″ to 2″ in open or dry pipe.

MUELLER made the *first* Tapping Machine to successfully insert a corporation cock under pressure. Today *MUELLER* Machines make 90% of all the taps for American Public Service Companies.

For descriptions and prices, write to

H. Mueller Mfg. Co., Decatur, Illinois

PHONE BELL 153

Water, Plumbing and Gas Brass Goods and Tools

New York City, 145 W. 30th Street
Phone Watkins 5397

San Francisco, 635 Mission Street
Phone Sutter 3577

Sarnia, Ontario, Canada

Mueller Metals Co., Port Huron, Mich., Makers of "Red Tip" Brass Rod; Brass and Copper Tubing; Forgings and Castings in Brass, Bronze and Aluminum; Die Castings in White Metal and Aluminum; also Screw Machined Products

Company. Each size is built both of plain, belt-driven design and also with a self-contained electric motor outfit driven either through pinion and internal gears, or by short belt drive. The compressing end and electric motor of both gear and short belt drives are furnished mounted on common sub-base.

Among the special features of construction, the constant level lubrication system is the most important, others being the constant-speed unloader for plain belt drive, the centrifugal unloader for start and stop control machines, and the increased size of the water reservoir cooling pot. The constant level lubrication system automatically maintains a constant level of oil, insuring the right amount being discharged to all parts. Pet cocks determine the maximum and the minimum amount of oil in the reservoir. Above the reservoir and directly beneath the connecting rod is a constant-level pan, into which oil is pumped from the reservoir into this pan through an oil pump. A projecting stem on the connecting rod dips into this pan and distributes just a sufficient quantity of oil for proper lubrication.

The constant-speed unloader controls the unloading of the compressor by automatically opening the inlet valve when the receiver pressure rises above a predetermined amount, and when it falls a predetermined amount the unloader automatically releases the inlet valve and again starts the compressor. The centrifugal unloader allows the compressor to start under no load, which is necessary for automatic starting and stopping, and permits the electric driving motor to come up to full speed before the load is thrown on automatically.

The smallest size of these compressors is either air-cooled, where the service is intermittent, or water-jacketed for constant service. All other sizes are built with water jacket of the reservoir type and of generous size.

THE TRAFICON

A traffic light set in the pavement at a street intersection is being manufactured by the Line Material Company under the name of "Directing Traficon" and "Regulating Traficon." The former consists of a heavy steel casting extending 8½ inches above the street surface and containing on each side a bullseye lens set in a recess perpendicular to the pavement and protected on each side by a heavy flange. Light is thus thrown down each of the four intersecting streets. If desired, red lenses can be placed in the line of one street and green lenses in that of another. Being low-lying, the "traficon" is directly in the line of the driver's vision and compels attention. It is rugged enough to withstand severe shocks.

The "Regulating Traficon" contains a stop light surmounting the hood, the extinguishing of the "stop" light being permission for the traffic to "go." "Traffic change" is indicated by a winking of the light above the lens. The device can be set to operate automatically or can be under the control of an officer standing at the street curb.

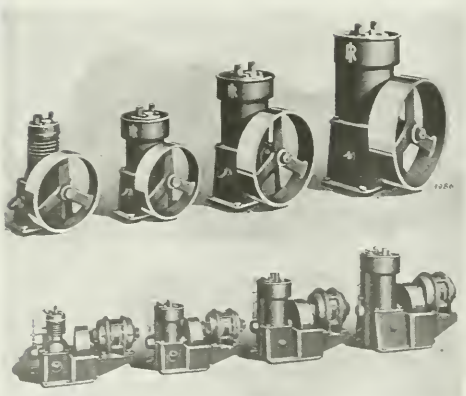
AVERY 20-35 H.P. TRACTOR FOR 1923

The Avery Company announce for 1923, an improved 20-35 H.P. tractor. The most noticeable change is in the external appearance. The cab has been eliminated, the fenders cover the full width of the rear wheel and extent from the platform well over more than half their circumference. The hood running back from the radiator includes the fuel tank and affords a substantial cover protection for the motor.

The power of the motor is increased 25 per cent and the Company has adopted a cooling system with cellular radiator, water pump and fan, and the Madison Kipp mechanical lubricator for oiling the working parts of the motor. The weight of the tractor is 7,500 lbs. which is considered very light for the drawbar efficiency.

DIRECTING TRAFICON.

REGULATING TRAFICON.



TYPE FIFTEEN AIR COMPRESSORS.

3"x3" air cooled, and 3"x3", 3½"x4" and 4¼"x5" water reservoir cooled machines. Upper row — Belt-driven.

Lower row — Electrically-gear-driven.

INDUSTRIAL NOTES

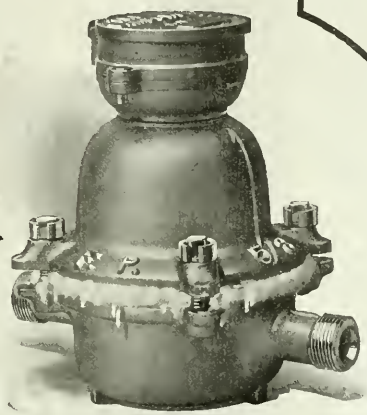
RESEARCH ON STEEL PIPE CORROSION

The National Tube Company has established an industrial fellowship in the Mellon Institute of Industrial Research of the University of Pittsburgh, the aim being a systematic study of practical methods for preventing corrosion of hot water supply systems; also giving attention to the classification of waters of various chemical compositions with respect to their relative corrosive action upon iron and steel, particularly in the line of pipe lines, boiler economizers, tubes, etc. The present incumbent of the fellowship is Clifford R. Texter.

AUSTIN MACHINERY CORPORATION

The Austin Machinery Corporation has consolidated the main sales office at Chicago with its Engineering and Production department at 3,500 Dorr street, Toledo, Ohio. This will lend dispatch to the handling of orders for both machines and repairs and will be of mutual benefit to both the Austin organization and its many customers. However, a branch sales office will be maintained at Chicago, Suite 603, Railway Exchange Building, for the convenience of contractors in and near Chicago.

$ SAVED IN REPAIRS



Note the Slitted Brass Collars

These collars open under excessive pressure caused by frost allowing top and bottom casings to part without damaging the meter in any way. After freezing, the slitted collars can be reclosed and the meter bolted anew.

WHY TAKE CHANCES?

Every meter damaged by frost means interrupted service, loss of time in repairs and cost of new parts.

LAMBERT FROST PROOF METERS

THOMSON METER COMPANY

100-110 BRIDGE ST., BROOKLYN, N. Y.

LAMBERT FROST-PROOF METERS

New Catalogs of Interest to City and County Engineers, Superintendents of Water Works, Superintendents of Streets, Contractors and All Engaged in Public Works

If you want any of these Catalogs, write the number on a postal, sign your name and address plainly, and mail it to PUBLIC WORKS, 243 West 39th Street, New York. The Catalogs will be sent to you promptly without charge or obligation.

CRANE EXCAVATORS

490. The Koehring Company, Milwaukee, Wis. Bulletins describing Crane Excavator No. 2 and Crane Excavator No. 3, the former having a 70-H.P. engine and the latter a 100-H.P. Gives detailed description of make, capacity, etc. 8 pages, 8x10-1/2.

NON-DETOUR ROAD CONSTRUCTION

491. Warren Bros. Company, Boston, Mass. Features the fact that traffic can continue to use a road where Warrenite-Bitulithic or Warren Pavement is under construction. 16 pages, 6x9.

MOUND TRAFFIC MARKER

492. Mound Traffic Equipment Co., Columbus, Ohio. Illustrates and describes the Mound Marker for directing traffic at street intersections. 4 pages, 8-1/2x11.

TREATED TIES AND TIMBERS

493. Century Wood Preserving Company, Pittsburgh, Pa. Discussion of the advantages of wood preservation and the processes used therefor, including use of creosote and zinc chloride. 24 pages, 8-1/2x11.

TIME STUDY OF CURB CONSTRUCTION

494. The Heltzel Steel Form & Iron Company, Warren, Ohio. Gives actual costs of setting Heltzel forms for concrete curb and roadway on a city street. 4 pages, 8-1/2x11.

AUSTIN-WESTERN SWEEPERS

495. Letters from city officials of Detroit, Niagara Falls and Jacksonville, giving actual figures as to amounts of work done, unit costs, etc., in the use of Austin-Western sweepers for street cleaning. 21 pages, 8-1/2x11.

CONTINUOUS FILTERS

496. Oliver Continuous Filter Company, San Francisco, Calif. Description of continuous automatic vacuum filters, horizontal filter tables, and vacuum and other pumps. Has been experimented with for de-watering sewage sludge. 4 pages, 8-1/2x11.

STEAM-DRIVEN AIR COMPRESSORS

497. Westinghouse Traction Brake Company, Pittsburgh, Pa. Description of steam-driven air compressors of the cross compound type. Small portable plants used for road-building and other construction work. 12 pages, 8x10-1/2.

WESTINGHOUSE AIR COMPRESSORS

498. Westinghouse Air Brake Company, Pittsburgh, Pa. Complete catalogue of steam-driven, motor-driven and belt-driven air compressors and accessories manufactured by this company, together with tables of reduction of air volume under pressure, velocity of air through orifices, etc. 100 pages, 6x9.

HOT-WATER METERS

499. Simplex Valve & Meter Company, Philadelphia, Pa. Catalogue of hot water meters and meter registers. 8 pages, 4x10-1/2.

RECORDING THERMOMETERS

514. The Foxboro Company, Inc. Foxboro Recording Thermometers are described and their advantages set forth in a four-page leaflet, 9½ x 12.

BALMER REFUSE DESTRUCTORS

515. "Refuse Collection and Disposal" and "The Refuse Disposal Problem in Small Communities." Two pamphlets, of 18 and 12 pages, respectively, issued by the Balmer Corporation, describing the Balmer destructors in Buenos Aires and Montevideo.

MORSE-BOULGER DESTRUCTORS

516. Pamphlet describing Morse-Boulger destructor and giving suggestions for preparing plans for refuse destruction service. 18 pages, 6x9 ins.

STREET SWEEPING SUPPLIES

517. Catalogue of rattan, corn, bamboo, hickory and wire push brooms, and street sweeper brooms, and street scrapers. 111 pages, 5x7 ins.

FOX ROTARY SNOW BROOM

518. Describes attachment to be mounted on any standard chassis manufactured by the Fox Rotary Snow Broom Co. and used last winter for opening snow-covered highways. Also used for summer sweeping. 12 pages, 6x9 ins.

WATSON DUMPING WAGONS

520. Descriptions and specifications of grading, ash and asphalt bottom-dump wagons of various capacities and styles. 32 pages, 10x7 ins.

STREET CANS

519. Describes waste paper and white wing cans made by the Cleveland Wire Spring Co. 1 page, 6x9 ins.

COLUMBIAN WAGONS AND CARTS

521. Catalogue of farm, bottom dump, end dump and wet garbage wagons, and carts. 40 pages, 7½x9½ ins.

GARBAGE CARTS AND WAGONS

522. Catalogue of steel body round-bottom carts, and end-dump carts and wagons, made by Geo. H. Holzbog & Bro. 12 pages, 7½x10 ins.

INDUSTRIAL NOTES

(*Continued from page 24*)

LARGE VALVES IN DETROIT FILTER PLANT

Detroit's new $6,000,000 filter plant is practically completed except for placing the filtering medium. Among the interesting features of this plant are the large sluice gates built by the Michigan Valve and Foundry Company, which made all of the special fittings. There are three pairs of gates, measuring 24 ft. x 5 ft., 14 ft. x 8 ft. 6 in. and 7 ft. x 9 ft. respectively. The 24-foot gates are the largest leaves of their type in use. In each case large size was necessary because there was not sufficient space available for double gates; therefore one huge gate was built by bolting together two separate castings. The 14 ft. x 8 ft. 6 in. gates have even larger area, and are said to be the largest single casting leaves that have been built. Here, too, spaces only 18 feet long were available, making it impossible to employ double gates with the necessary concrete walls between them. The 7 x 9 foot sluices operate automatically, and are designed to maintain a constant level in the settling basin.

MOTOR TRUCKS FOR 1923

The Federal Motor Truck Co. announces an entirely new line of trucks for 1923. The new models include a 1 to 1½ ton, pneumatic tire; a new 2½ ton; 3½ to4 ton; 5 to 6 ton; and both light and heavy duty trailer tractor.

The 2½ ton is made with four wheel hases—120 inches (short), dump chassis 144 inches, standard 156 inches, and 168 inches (long). The new model is slung much lower than the average truck, the clearance from ground to frame when loaded being 30½ inches. The wheels are artillery type. The motor is a Continental vertical L head type, developing 35 horsepower at normal engine speed.

The 1 to 1½ ton will have a 30 h.p. motor; the 3½ to 4 ton will have a 42 h.p., and the 5 ton a 46 h.p. The light tractor will have a 30 h.p. motor, and the heavy tractor a 42 h.p.

WATER METERS

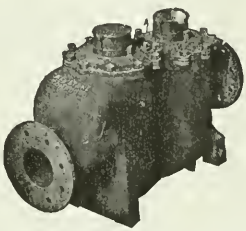
FOR EVERY KIND OF SERVICE

Also Meters for Gas, Oil, Gasoline, Air and Other Fluids

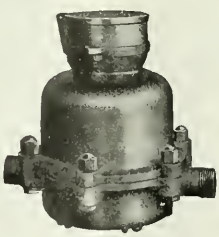
Arctic

Eureka

Accuracy
Efficiency
and Continued Satisfactory Service at the lowest Maintenance Expense are Characteristic of these Meters.



Keystone-Compound



Keystone

PITTSBURGH METER COMPANY

GENERAL OFFICE AND WORKS, EAST PITTSBURGH, PA.

SALES OFFICES

NEW YORK, 50 Church Street
CHICAGO, 5 S. Wabash Avenue
KANSAS CITY, Mutual Bldg.
COLUMBIA, S. C., 1433 Main Street
SEATTLE, 802 Madison Street
LOS ANGELES, Union Bank Bldg.

The Winter Peril

of Frozen Hydrants is Removed with the

ROSS THAWING DEVICE

THE fire alarm on a zero day fills firemen's minds with apprehension as to the possibility of a frozen hydrant, and the incidental delay in fire fighting.

The Ross Thawing Device will quickly and effectively overcome this handicap. It consists of a jacket tank surrounding a steam coil, and operated on the flash boiler principle, producing steam at the nozzle twenty seconds after the flame is lighted.

The water, which is forced from the tank into the red hot coil, by means of hand pump, becomes superheated steam which will thaw more quickly than any other known agent. The heat is furnished by a standard Prestolite Acetylene tank, which is part of the outfit.

Ready for operation, the Ross Thawing Device is 25 inches tall, and weighs only 135 pounds. 28½x12 inches at the base; easily portable. Simple in operation.

Every fire department should be equipped with one or more of these devices.

Upon receipt of your request our nearest branch office will immediately forward you complete information and prices.

AMERICAN-LAFRANCE FIRE ENGINE COMPANY, INC.

ELMIRA, N.Y.

BRANCHES
NEW YORK
BOSTON
ATLANTA
PITTSBURGH
CHICAGO
DALLAS

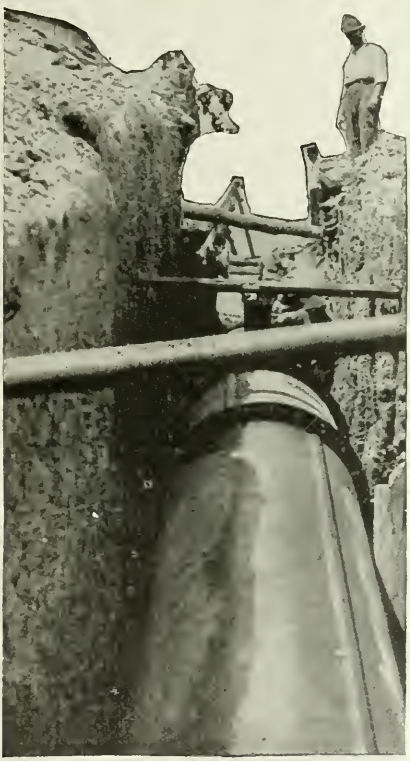
CANADIAN FACTORY
TORONTO, ONT.

BRANCHES
DENVER
MINNEAPOLIS
LOS ANGELES
SAN FRANCISCO
WASHINGTON
PORTLAND

LOCK-BAR

Before Closing

STRONG AS THE PLATE ITSELF



The Only Pipe with the 100% Joint

Lock-Bar Steel Pipe will carry approximately 43% greater working pressure than double riveted steel pipe. The longitudinal joint of Lock-Bar is 100% efficient.

On account of the smooth interior of Lock-Bar (absence of rivets, except at circumferential joints thirty feet apart), Lock-Bar is given a preference of 3 inch in diameter over riveted pipe for same carrying capacity.

For like capacity and like pressures Lock-Bar has the advantage of saving in metal on account of smaller diameter and thinner plate. The saving increasing with the diameters and pressures.

Executives write for "Handbook on Pipe"

EAST JERSEY PIPE COMPANY

7 DEY STREET NEW YORK

ACCURATE DURABLE
DEPENDABLE

"WATCH DOG"
FROST PROOF METERS

effect an enormous saving in labor and repairs

The Frost Proof Meter may be had in all sizes up to and including 1¼".

The frost plate or bottom cap is brass lined as an added protection to the working parts.

The cap is designed to break when subjected to undue strain. When this fracture occurs, only the plate is damaged, the measuring unit being saved from distortion by the play afforded by the loosened plate. Replacement is easy—the cap is removed, a new one is replaced, and all that remains to be done is to pull up the bolts.

A hammer is unnecessary; no blows are required.

Waterworks officials and superintendents will find our catalogue of special interest.

GAMON METER COMPANY

280-294 SOUTH STREET NEWARK, N. J.

Chemicals for Water Purification

We manufacture the highest grades of

Sulphate of Alumina

also

Chloride of Lime

and

Liquid Chlorine

Pennsylvania Salt Manufacturing Company

WIDENER BLDG. PHILADELPHIA, PA.

MAKE YOUR SERVICE CONTROL 100% EFFICIENT

BY THE ADOPTION OF THE

C.M.B. SERVICE BOX

ELIMINATES ALL TROUBLE

No more broken nor lost bolts, nor tops.

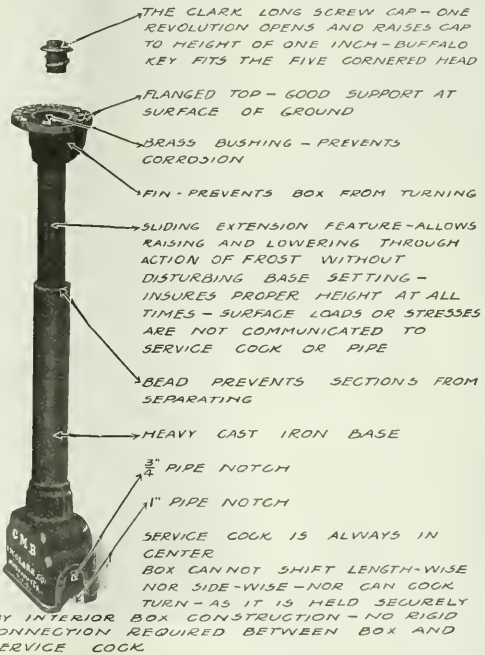
No more digging up to adjust to grade.

No more trash filled boxes.

No more damaged service cocks or leaky pipes caused by heavily loaded wagons.

No more inoperative cocks by reason of failure to engage key.

Uniformity on all services, as same box fits all sizes up to 2″ inclusive.


THE CLARK LONG SCREW CAP – ONE REVOLUTION OPENS AND RAISES CAP TO HEIGHT OF ONE INCH – BUFFALO KEY FITS THE FIVE CORNERED HEAD
FLANGED TOP – GOOD SUPPORT AT SURFACE OF GROUND
BRASS BUSHING – PREVENTS CORROSION
FIN – PREVENTS BOX FROM TURNING
SLIDING EXTENSION FEATURE – ALLOWS RAISING AND LOWERING THROUGH ACTION OF FROST WITHOUT DISTURBING BASE SETTING – INSURES PROPER HEIGHT AT ALL TIMES – SURFACE LOADS OR STRESSES ARE NOT COMMUNICATED TO SERVICE COCK OR PIPE
BEAD PREVENTS SECTIONS FROM SEPARATING
HEAVY CAST IRON BASE
¾" PIPE NOTCH
1" PIPE NOTCH
SERVICE COCK IS ALWAYS IN CENTER
BOX CANNOT SHIFT LENGTH-WISE NOR SIDE-WISE – NOR CAN COCK TURN – AS IT IS HELD SECURELY BY INTERIOR BOX CONSTRUCTION – NO RIGID CONNECTION REQUIRED BETWEEN BOX AND SERVICE COCK
C M B

THINK WHAT THIS MEANS TO YOU

Furnished in base for lead pipe and base for Minneapolis pattern cock; also with extension rods and combination keys when desired.

Perfectly adapted to use everywhere regardless of type of box now in use. It does not require additional number of wrenches nor keys.

A wonderful LIGHT WEIGHT WRENCH made up of tubing and fitted with steel key to operate top and fitted with steel combination base to operate cock or to operate extension rod. Your department equipped with CLARK WRENCHES greatly facilitate operation, one wrench ONLY being required to operate all Service Cocks of all sizes up to 2″ whether equipped with rod or without rod. We arrange to equip you with these wrenches free.

You will be surprised at the low price. Ranks with the lowest priced Service Boxes on the market.

ADOPTED BY MANY WATER DEPARTMENTS

Clark Meter Boxes—Southern
Clark Meter Boxes—Northern
Clark Meter Testing Machines—Six Models—Bulletin B.
Clark Testing Instruments Increase Earnings—Bulletin C.
The New C. M. B. Service Box Corrects All Service Box Faults, Valve Boxes, Valve Housings, etc.—Bulletin D.
Water Works Pumps of All Kinds—Bulletin E.
Municipal and Miscellaneous Castings—Bulletin F.
Venturi Meters—Check Your Pumpage and Waste—Bulletin G.
CAST IRON PIPE, FIRE HYDRANTS and VALVES, AIR VALVES, BRASS GOODS, etc.—Bulletin H.

WRITE FOR BULLETINS

H. W. CLARK COMPANY

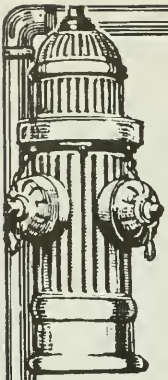
EVERYTHING FOR THE WATER WORKS AND MUNICIPALITY

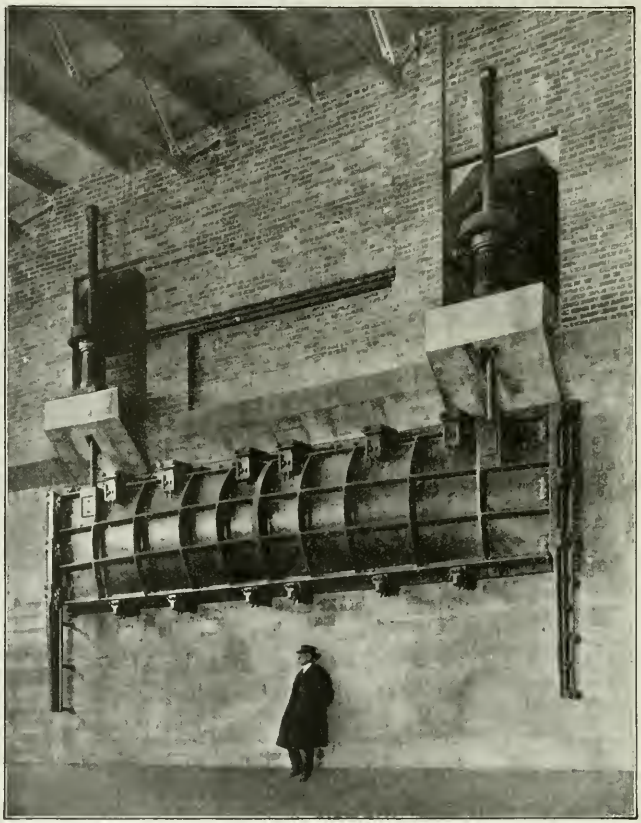
1308 Broadway, MATTOON, ILLINOIS, U.S.A.

New York Salt Lake City Chicago
Memphis San Francisco Buffalo

THE CLARK METER BOX TRADE MARK REGISTERED PROTECTION

"GO AHEAD"





"Michigan" compression hydrants embody points of simplicity, efficiency and durability that make them the recognized standard in design.

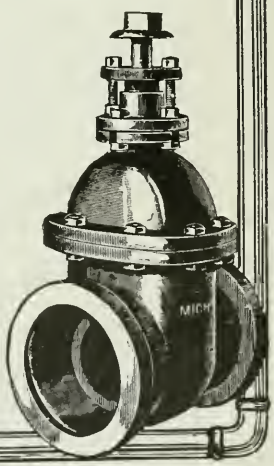
Big Tasks Well Performed

—a case in point

QUALITY and precision are the hall-marks of "Michigan" products. Backed by the experience of 55 years of effort intelligently directed, and spurred by a willingness to serve that is typified within the organization by the slogan, "Go Ahead," we are equipped and ready to execute commissions calling for the highest standards of dependability.

Reproduced above is a typical "Michigan" achievement—the largest single-leaf sluice gate in the world. It was produced by us to meet special engineering conditions presented in the construction of Detroit's new $6,000,000 filtration plant, the largest single-unit system of its type in existence.

Complete Catalog upon request.



MICHIGAN VALVE & FOUNDRY COMPANY
DETROIT, MICHIGAN

A "FORD" in the Pump Field

Where there's water to lift, an Evinrude Centrifugal will save you money on the job.

THAT'S the verdict of Evinrude Centrifugal Pump users all over the country.

For example, a Massachusetts contractor writes in: "I had four men with two sewer pumps trying to pump out a ditch and they could not keep ahead of the water. I installed an Evinrude Pump and in an hour I put my men to work on another job."

A road builder in Denver, Colo., writes: "No contractor on a road job can afford to be without an Evinrude Pump. Its dependability and portability make it so useful. If an emergency occurs at any place on the job, the Evinrude can be tossed in the back seat of the flivver and it will be at work in no time at all."

A Kansas City bridge builder says: "We have three gas pumps, two four-inch and one of your little units which we lower down in the casings, and after the larger pumps quit us the little Evinrude always holds the water at working level."

City fire departments, dredge companies, logging concerns, public service companies, irrigators and the score of other users of this husky pumping outfit report the same success.

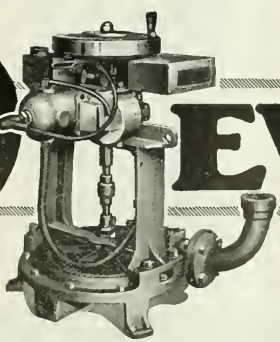
The Evinrude with its capacity of 5000 gallons of water at a 20-foot head is the only self-powered pump of its kind—driven by the same dependable 2 H.P. gasoline engine now used in 140,000 Evinrude rowboat motors. Weighs only 115 pounds—may be easily moved by two men. It is so compact it may be lowered into the ditch, caisson or excavation—right down to the job and submerged in the water. Can be used with or without suction line. No "installation" necessary.

Write for booklet illustrating the many uses of the Evinrude Centrifugal Pump.

Dealers: *Some desirable territory is still open. Write for our proposition.*

EVINRUDE MOTOR COMPANY
18 LAKE STREET MILWAUKEE, WIS.

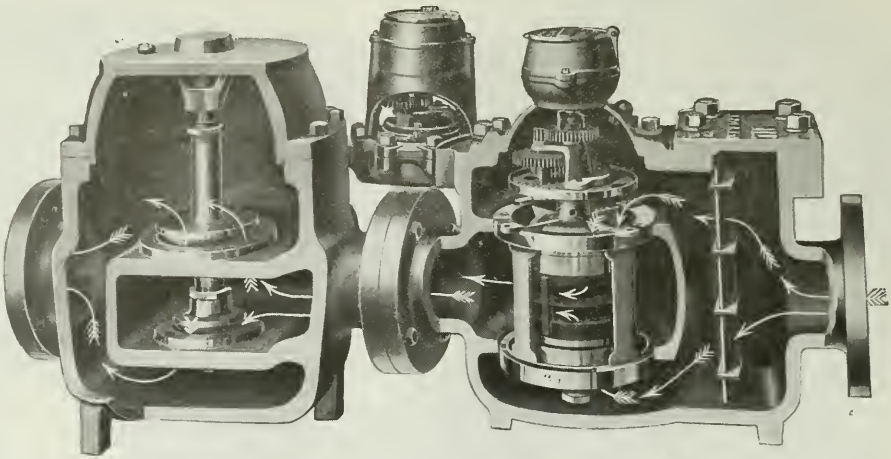
5000 GALLONS per hour at 20 ft. head



EVINRUDE
CENTRIFUGAL PUMP

For users requiring a more powerful pump the Evinrude No. 1½ is recommended. 7400 gallons per hour at a 20-foot head—3½ H. P. Evinrude motor. Price $200.

Price: $150.00 F.O.B. MILWAUKEE



NILO COMPOUND METER

Consists of three separate and complete units which may be used individually, if desired. Working parts of Nilo Velocity Meters, King Disc Meters and Union Compounding Valves are each assembled in a single unit, readily accessible for inspection without disturbing pipe connections. Catalogue P-52.

UNION WATER METER INC. CO 1868 WORCESTER MASS.

Makers of approved water works specialties since 1868.

UNION WATER METER CO. *Incorporated 1868* **WORCESTER, MASS.**

You need this book

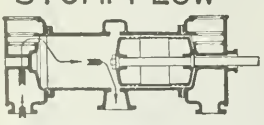
on the

UNA-FLOW STEAM ENGINE

Second English Edition

By Prof. J. Stumpf

STUMPFLOW



DESIGN

$5 postage prepaid

Write Now about your power problems to his own agent and engineers.

STUMPF UNA-FLOW ENGINE CO., Inc.
206 E. Genesee Street
SYRACUSE NEW YORK

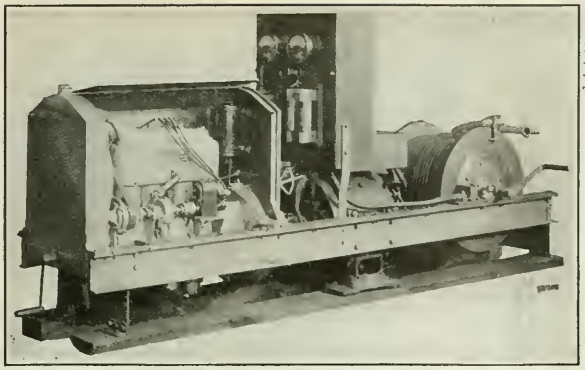
EMERSON PUMPS

ON EVERY CONTRACT

The Emerson Steam Vacuum Pump is practically indestructible, is entirely self-contained, and has no working parts exposed or in sight. No foundation is required. Outside belting, shafting, or engine; self-priming and so simple that skilled attention is unnecessary. Ability to handle solid matter and entrained air without stopping, permits their use on work where other pumps are hopelessly inadequate. They will operate in any position. Requires no exhaust pipe. Steam consumption is low. Takes but little space in shaft.

Catalogue on request.

EMERSON PUMP and VALVE CO.
ALEXANDRIA, VA.



Prepare for Freeze-ups

GASO-ELECTRIC THAWING UNIT

Takes but 5 to 10 minutes to complete a thaw

This apparatus will more than save its cost in one season. Extremely low cost per thaw. A necessity to any city water department where freeze-ups occur during winter. No street disturbance or digging.

Engineers and contractors are requested to write for our proposition.

Manufactured by **Auto Engine Works,** *St. Paul, Minn.*

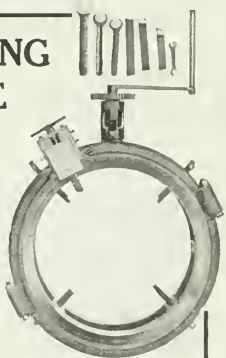
SPECIALTIES
FOR WATER WORKS

DEVICES FOR FILLING SPRINKLING WAGONS

WILL pay for themselves in savings effected on repairs to hydrants. Will save great waste of water, as regular hydrants when used are usually left in leaky conditions. No wrenches necessary to operate. Nothing to break. Nothing to get out of order.

PIPE CUTTING MACHINE

Cuts as easily and smoothly as if done in a lathe



No. 1. Size for cutting 4", 6" and 8" pipe.

No. 2. Size for cutting 10", 12", 14" and 16" pipe.

No. 3. Size for cutting 18", 20" and 24" pipe.

No. 4. Size for cutting 30" and 36" pipe.

No. 5. Size for cutting 42" and 48" pipe.

Makers of Smith Tapping Machine, Valves, Lead Furnaces, Pipe Cutting Machines, Gate Valves and Other Water Works Specialties

WRITE FOR CATALOGUE

THE A. P. SMITH CO., EAST ORANGE, N. J.

MATHEWS FIRE HYDRANTS

• • •

The recognized standard for over 50 years

Frost-Proof
Positively Automatically Drained
Always Dependable

GATE VALVES

FOR ALL PURPOSES

CAST IRON PIPE

AND FITTINGS

"REDUCED" FITTINGS

Write for Catalog and Prices

R. D. WOOD & CO.

Philadelphia, Pa.

Clean Water Mains Deliver Full Capacity

If there is growth or deposit in your mains it will seriously affect the carrying capacity. It will cost a great deal less to send water through clean mains.

During the past 15 years we have cleaned mains in several hundred cities and the results in increased pressure and reduced operating costs have been thoroughly satisfactory.

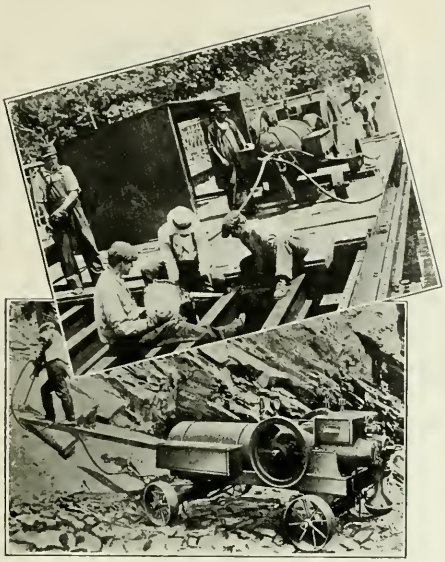
We are glad to confer with municipal officials or water companies.

National Methods Are Patented

National Water Main Cleaning Co.

54 Church St. New York

Liquid Chlorine
38740
Your order for a 100-lb. cylinder of CHLORINE will be executed with the same care and promptness as that of a larger quantity.
By the same token and by reason of our facilities, we are able to dispatch a tank car with that same precision and exactitude.
Electro Bleaching Gas Co
PIONEER MANUFACTURERS of LIQUID CHLORINE
EBG



SCHRAMM
Compressors
over 4000 in use!

The large number of "SCHRAMM" Compressors in use is the best evidence of the entire satisfaction which our customers have experienced with these units.

In addition to this over 70% of our business so far this year is traceable to satisfied users. This is the best recommendation that we can offer to support our claim that "SCHRAMM" Compressors are more efficient, more economical in operation, and more sturdily built than ever before.

Complete equipments can be had for rock drilling, riveting, woodboring, reaming, calking, tamping, sand blasting, paint spraying or any other pneumatic tool use. Tell us your requirements and let us send you bulletins describing your job with our recommendation.

SCHRAMM, Inc.

Home Office and Factory: West Chester, Pa.

54 Dey Street NEW YORK | 605 S. Dearborn Street CHICAGO | 709 Arch Street PHILADELPHIA

ENGINES

COMPRESSORS

PUMPS

HOISTS

MIXERS

BADGER WATER METERS

Positive and Accurate on all streams

From the Smallest Leak to the Full Capacity of Pipe

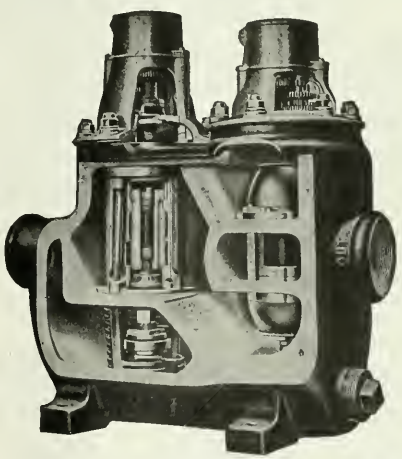
For Every Service

Our policy of selling a high-grade product is responsible for the greatly increased demand for Badger Meters.

We have the factory facilities and sales organization to handle a rapidly growing business.

Our special bulletin describing the Badger Compound Meter illustrated herewith will be sent upon request. Also bulletins on Disc Meters in sizes 5/8" to 4" inclusive, and on Turbine Meters in sizes 2" to 6" inclusive, if you wish them.

Write us your requirements



BADGER METER MFG. COMPANY

FACTORY AT MILWAUKEE, WIS.

Sales and service offices:

CHICAGO, ILL. 111 W. Washington St. | KANSAS CITY, MO. 414 Interstate Bldg. | BROOKLYN, N. Y. 32 Court St. | DENVER, COLO. 1621-39 15th St.

WATER PIPE—GAS PIPE

NATIONAL Pipe is Made Right—On New Equipment—By Use of Special Cores.

NATIONAL Pipe has Smoothest Inside Finish—Easiest to Work.

PROMPT SHIPMENTS

National Cast Iron Pipe Co.

BIRMINGHAM, ALA.

SALES OFFICES

(Write Nearest Office For Prices)

1266 Peoples Gas Bldg., Chicago, Ill. **903 Commerce Bldg., Kansas City, Mo.**

916 Kirby Bldg., Dallas, Texas

SALES REPRESENTATIVES

Wm. P. Horn Company, Rialto Building, San Francisco, Cal.

Pacific Pipe & Supply Company, Los Angeles, Calif.

STOCKS CARRIED AT

Chicago, Kansas City, Dallas, Los Angeles, and San Francisco

One Billion GALLONS

The total daily capacity of municipal filtration plants installed by us.

500 Communities Supplied

The Dry Feed machine illustrated is the most approved method of feeding chemicals in the science of water treatment. Overcomes the necessity for solution tanks.

The most perfect method of feeding chemicals in dry or powdered form.

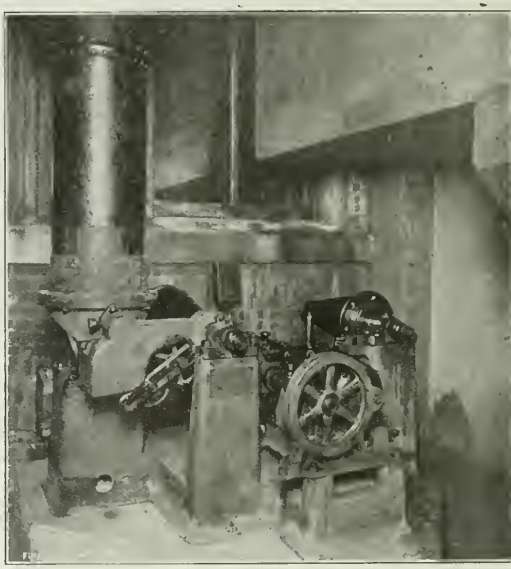
NOT AN EXPERIMENT but a PROVEN SUCCESS

Send for bulletin 22-2

The New York Continental Jewell Filtration Company

Nutley, N. J.

New York **Chicago** **Montreal**

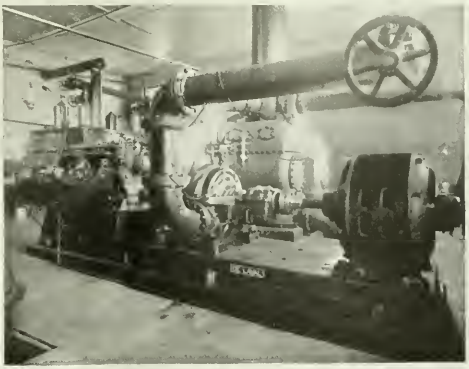


The ORIGINAL DRY FEED MACHINE

Sterling
THE ENGINE of REFINEMENT
For the finest boats that float

POWER INSURANCE

Use STERLINGS during emergency (storms or mechanical breakdowns), for peak load, and to reduce power costs for fire protection. State boards of health frequently insist on duplicate power in sewage systems. Fire underwriters demand a secondary power and often lower the insurance rate, or raise it if a standby unit is not used. Costs $20 to $25 per H. P.



6 cylinder 145 H. P. STERLING direct connected 2 stage DeLaval centrifugal, 1500 R. P. M. 1½ million gal. per day, 280 ft. head. Reserve pump installed at Bath Water district, Bath, Me. By Power Equipment Co., Boston, Mass.

STERLING ENGINE CO., Dept. C-5 BUFFALO, N. Y.

40 to 300 H. P. at 1200 to 1500 R. P. M.

THIRTY INCH PIPE LINE

Cast Iron Pipe at Syracuse

Showing Bell and Spigot Joints

Few cities are lucky enough to have a supply of pure water available within their limits. Syracuse, N. Y., is no exception to this rule. There the lake from which they obtain their water is located 20 miles away over the hills.

When their supply line was laid out, a desire to practice true economy led to the installation of a permanent material. U. S. Cast Iron Pipe was purchased and installed. The supply line consists of over nineteen miles of 30″ pipe and a mile and a half of 42″ pipe. In spite of the rough country through which this line was laid it has given perfect satisfaction and will serve the community for decades to come.

United States Cast Iron Pipe & Foundry Co.

General Office: Burlington, New Jersey

SALES OFFICES

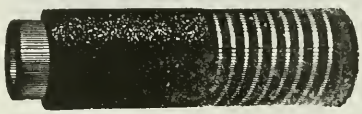
Philadelphia
Pittsburgh
Cleveland
Minneapolis

Chicago
St. Louis
Buffalo
Cincinnati
Kansas City

New York
Birmingham
San Francisco
Dallas

Bourbon Fire Hydrants, Gate Valves
AND
Extension Valve Boxer
WATER WORKS and FIRE DEPARTMENT SUPPLIES

THE BOURBON COPPER AND BRASS WORKS CO.
618-620 E. FRONT ST. CINCINNATI, OHIO



It Carries More Water for Its Diameter Than Any Iron Pipe

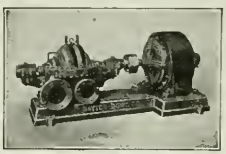
WYCKOFF WOOD PIPE is not impaired by the effects of electrolysis acid fumes or corrosion. It is light, strong and very durable. Lengths, 6 feet to 12 feet long. Size for size, it carries 14 per cent. more water than iron pipe. Costs less for transportation because it is lighter and easier to handle.

May we send Catalog giving fullest details?

A. WYCKOFF & SON COMPANY, Elmira, N. Y.

H. H. White - - 1503 Fourth Nat'l Bank Bldg., Atlanta, Ga.
Johnson-Peters Co. - - - - Pittsburgh Terminal Warehouse, Pittsburgh, Pa. 551 West 14th Place, Chicago, Ill.

DAYTON-DOWD
CENTRIFUGAL



Built for Continuous Economical Service

Investigate!

DAYTON-DOWD CO.
357 York St.
QUINCY, ILLINOIS
Offices in Principal Cities

PUMPS

SLUICE GATES
SHEAR, FLAP, PLUG DRAIN
AND
BUTTERFLY VALVES
FLEXIBLE JOINTS
COLDWELL-WILCOX CO.
Box 574 Newburgh, N. Y.

If You Have a DEEP WELL ending in WATER-BEARING SAND OR GRAVEL.

equip it with the COOK PATENT BRASS TUBE WELL STRAINER and secure the maximum capacity of the well free from sand or particles of any kind. These strainers are in use by the Department of Water Supply of New York City, Parkersburg, W. Va., Memphis, Tenn., and Dayton, Ohio.

Upon the completion of the well, allow me to quote upon a Steam Belt or Motor Driven Deep Well Pumping Outlet.

Write for New Catalogue

A. D. COOK, Manufacturer Lawrenceburg, Ind., U. S.

T. J. MITCHELL, Vice-President-General Manager
W. C. HOWE, President
JOHN M. BAILEY, Vice-President-Secretary

Standard Inspection Co.
Inspecting Engineers

954 Century Building Pittsburgh, Pa.

INSPECTION

Road building material of all kinds. Cast iron, steel riveted and lock bar pipe. Structural steel for Buildings and Bridges. Inspection Road Building Equipment, new and second-hand. Storage Tanks.

HAVE YOUR MATERIALS INSPECTED AND TESTED—SAVE IN YOUR MAINTENANCE COST

BRANCH OFFICES IN Principal Cities

When You Write Advertisers You Will Do Them and Us a Favor by Mentioning PUBLIC WORKS

A REAL CUSHION TRUCK TIRE

Copyright 1922, by The Goodyear Tire & Rubber Co., Inc.

At the left is seen the famous All-Weather Tread and the Indented Sidewall of the new Goodyear Cushion Truck Tire. Right—a cross-section showing the Goodyear Patented Hollow-Center

Goodyear has produced a real cushion truck tire embodying both the original Goodyear Hollow-Center Cushion and the famous All-Weather Tread.

It unites in one tire the resilience of the cushion, the wearing quality of the solid, and the tractive power of the All-Weather Tread.

It is a development of the standard Goodyear Hollow-Center Cushion Tire, more than 30,000 of which have been proved in actual service during the last five years, and it is a distinct advance on that splendid tire.

The Goodyear All-Weather Tread Cushion Tire has a pressed-on base that defies base-separation troubles.

Its tread is the powerfully tractive All-Weather Tread design, insuring sustained headway under all road and weather conditions, saving fuel and engine strain by its sure gripping.

Its triple cushion design makes it a real shock absorber, resilient beyond any other tire excepting the pneumatic. It has the advantage of the patented hollow-center, the high, thick blocks of the All-Weather Tread, and a new sidewall pattern that permits easy compression under pressure.

The Goodyear All-Weather Tread Cushion Tire is made in all standard sizes, up to and including 7 inches, and is specified for all-'round equipment on light and medium duty vehicles and as front wheel equipment with Goodyear All-Weather Tread Solids on the rear, for heavier trucks.

For further information, write the Government Sales Department at Goodyear, Akron, Ohio, or Los Angeles, California.

In placing orders for new apparatus, you should definitely specify this Cushion, unless your needs are for Goodyear All-Weather Tread Solids or Goodyear Cord Truck Tires

GOODYEAR

The Disposal of Municipal Refuse

A modern incinerator is not only an indispensable necessity of all cities and towns, but it is the most sanitary and economical method of disposing of Municipal refuse.

The Nye system of incineration is one of only **three** distinct types of garbage incinerators built in this Country.

The Nye incinerator is the most efficient, most simple, most practical, as well as the most economical in **first cost, in operation** and **in upkeep,** because of its unique scientific design.

During the past eight years the Nye incinerator, like the automobile, has been improved, developed and refined to the highest state of efficiency and perfection.

The Nye incinerator is nationally known. For instance, during the present year Nye incinerators were being built at the same time in the States of New York and Texas, Virginia and Oklahoma, Florida and Minnesota.

There is no excuse for any town or city to be without a Nye incinerator. Our Company takes all the risk, as no payment or advance is required until the incinerator is completed at our cost and expense, and demonstrated in operation by the employees of the city. You get what you buy, and you know it before you pay.

It is a pleasure for us to give specific information and to answer all questions of inquiry.

The Nye Odorless Crematory Co.
MACON, GA.

NYE
ODORLESS
INCINERATORS
LOW COST
UNIT PLAN

Illustration from actual photograph shows typical fireproof Nye Incinerator

Miles and More Miles of HELTZEL STEEL FORMS

A Rail
A Pedestal
A Stake
that's all

The Union Paving Company of Philadelphia purchased nearly thirty thousand feet of Heltzel Steel Road Forms.

Their first order called for 3,000 feet; their second order called for 16,000 feet; their third order called for 10,000 feet.

During the first six months of this year over 150,000 feet of this form was sold in Illinois alone. Geo. T. Wilhelm used Heltzel Forms on his 60 mile job in Arkansas.

C. F. Lytle, Contractor, Sioux City, Iowa, used 8,000 feet and ordered 10,000 feet additional 6″ Heltzel Forms for his 48 mile job in Florida.

They all pin their faith to Heltzel Forms—WHY? Ask any one of them what they think of Heltzel Forms.

In the meantime, write for literature. You are not obligated by so doing. Why not write now? A one cent postal will bring full information.

The Heltzel Steel Form & Iron Co.

Warren, Ohio

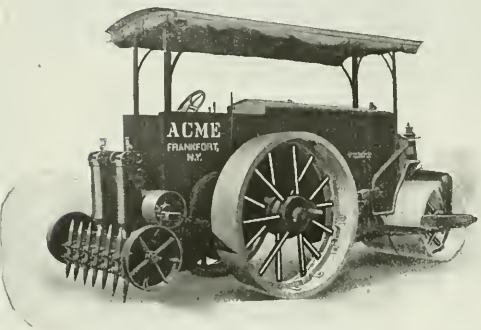
Largest exclusive builders of steel forms for Road, Sidewalk, Curb, Curb and Gutter and all types of concrete construction; Tamping Machines, Heltzel Hand Strikeoff Tamp, Heltzel Rotary Steel Float, and other accessories.

ACME

Equipment

Will Reduce Your Operating Costs

Its reliability enables you to complete your contract on time



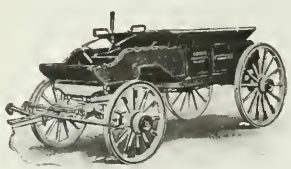
4 CYLINDER MOTOR ROLLER

Find out about the full line of Acme Road Building Machinery.

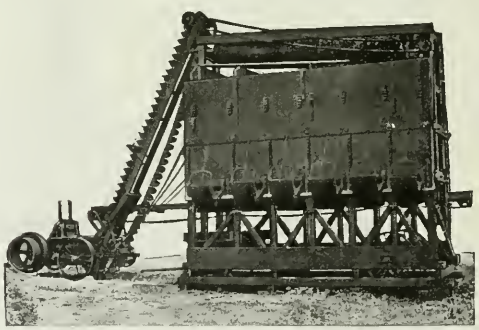
We manufacture: Acme Four-Cylinder Motor Road Roller; Rock Crushers—Solid Cast-Steel Frame Portable and Stationary; Elevators, Screens, Portable Storage Bins; Tom Thumb Graders, Patrol to Traction; Portable Gravel Screening and Unloading Plants; Wagons, etc., Steam Road Rollers.

WRITE FOR CATALOGUE

ROAD GRADERS



BOTTOM DUMP WAGON



MTD. FULL PORTABLE CRUSHING AND SCREENING PLANT

ACME ROAD MACHINERY CO.

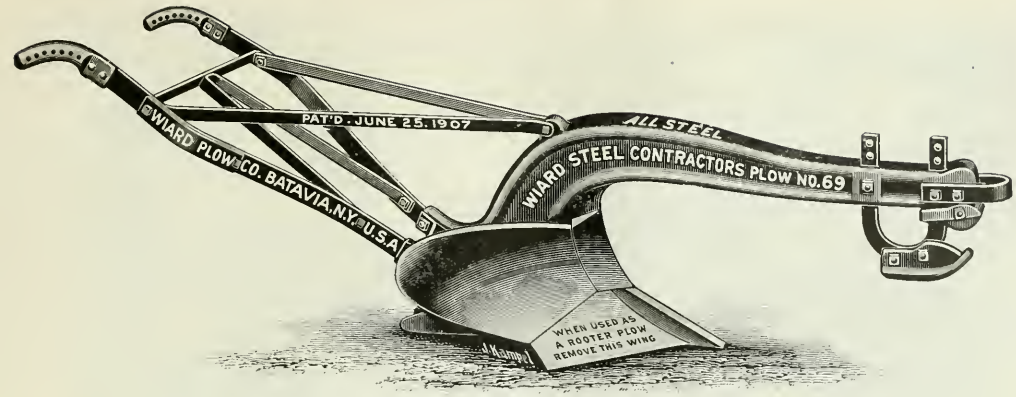
FRANKFORT, N. Y.

BRANCHES:

NEW YORK OFFICE: 120 Liberty Street
EXPORT OFFICE: 120 Liberty Street, New York City
BOSTON OFFICE: 141 Milk Street, Boston, Mass.
Provident Bank Building, CINCINNATI, OHIO
Equitable Building, BALTIMORE, MD.
127 North Dearborn Street, CHICAGO, ILLINOIS

WAREHOUSE DISTRIBUTORS:

YANCEY BROTHERS, Atlanta, Ga.
W. FRED CASEY CO., Charlotte, N. C.
CHOCTAW ROAD SUPPLY CO., Memphis, Tenn.
PHILIP GROSS HARDWARE & SUPPLY CO., Milwaukee, Wis.
CLYDE EQUIPMENT CO., Portland, Oregon
SPEARS WELLS MACHINERY CO., Oakland, Cal.


PAT'D JUNE 25, 1907
WIARD PLOW CO. BATAVIA, N.Y. U.S.A.
ALL STEEL
WIARD STEEL CONTRACTORS PLOW NO. 69
WHEN USED AS A ROOTER PLOW REMOVE THIS WING

—WIARD—

ROAD OR CONTRACTOR'S PLOW

For tearing up cobblestones and macadam—it can be used as a perfect rooter and pavement plow by simply removing the steel wing below the moldboard—thus making a TWO-In-One plow for all around work. Ordinarily, the contractor has one plow for general purpose or furrow work and another plow for rooter work or tearing up old pavements. The Wiard does the work of both and answers any and all purposes—means a less investment and keeping in stock extra parts for one plow only.

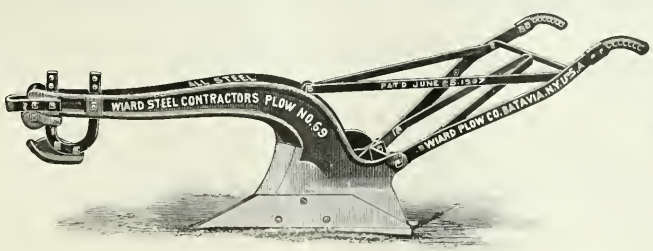
LIGHT AND STRONG

We make a full line of plows for every requirement.

Write for descriptive literature.

Wiard Plow Co., Batavia, N. Y.

USED AS A ROOTER PLOW



No. 69 (All Steel) Contractors' Plow, Landside View

Christmas Greetings to the Oil Industry

In the hustle and bustle of business
With its saving and slaving and grind
We're apt to accredit successes
To the works of our hands and mind.

But this space is taken to tell you
That we feel that the credit is due
For the progress we've made and the good will we've built
To the friendship of such folks as you.

THE HEIL CO.

Milwaukee Wisconsin

CITY OFFICIALS

are beginning to look into their Street Cleaning requirements for 1923 and naturally, when they think of street cleaning equipment they think of the wonderful line of

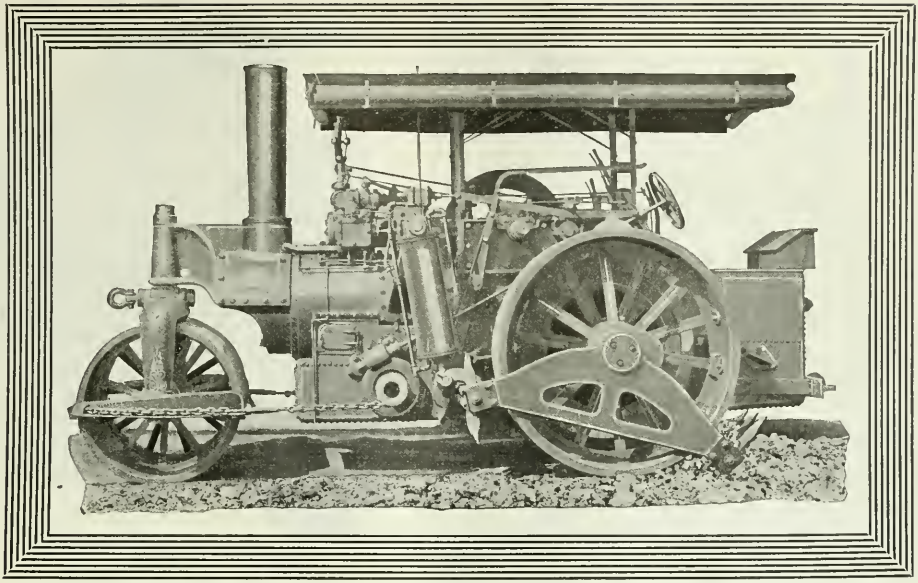
TIFFIN
FLUSHERS AND SPRINKLERS

noted for their superb design, splendid construction, economy of operation and superior working qualities.

Write for detailed information and catalog

Let us help you solve your problems.

The TIFFIN WAGON CO., *Tiffin, Ohio*



No Surface too hard or tough
for the
"BUFFALO" MAINTENANCE ROLLER

It is built for heavy rolling and for breaking up cement, asphaltic and Bituminous Concrete surfaces. The location of the loosening device enables heavy scarifying to be done close to the curb.

Scores of "Buffalo" Maintenance Rollers are now in service of counties, municipalities and contractors specializing in difficult work.

They provide increased rolling pressure for present and future demands.

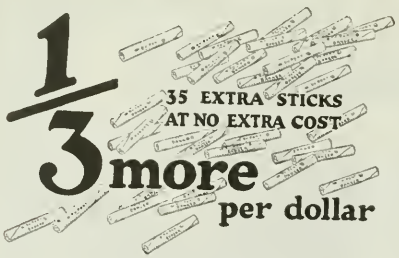
The Buffalo Springfield line includes road and street rollers of all weights and types—both steam and motor driven.

Buffalo Springfield Pressure Scarifiers can be attached in the field to rollers already in service.

INQUIRIES INVITED

The **Buffalo-Springfield Roller Co.**

Springfield, Ohio



A Guncotton-Nitroglycerin Dynamite Without a Headache

NITROGLYCERIN DYNAMITE has always been the standard high explosive. Until recently it has always had two defects, relatively unimportant in comparison with its basic advantages over other types of dynamite, but nevertheless marked disadvantages. First, it froze at a relatively high temperature, and second, it caused headaches.

Within the past year, the first of these disadvantages was removed through the production of a du Pont Straight Dynamite which functions with normal efficiency at 10° below zero.

Both disadvantages have now been removed in Dumorite—a guncotton-nitroglycerin dynamite, which is not only absolutely non-freezing but is the first dynamite with nitroglycerin content which will not cause headaches.

Under ordinary conditions, Dumorite does approximately the same work as 40% dynamite stick for stick. And you can buy 135 to 140 sticks of Dumorite at the same price as 100 sticks of "40%."

Dumorite is saving money today for operators in most kinds of blasting work. If it is adapted to your work, your dynamite dollar will be worth $1.35.

Write our nearest branch office outlining your requirements and put the problem of reducing your blasting costs up to our Service Department.

E. I. du Pont de Nemours & Co., Inc.
Explosives Department
Wilmington, Delaware

BRANCH OFFICES

Birmingham, Ala.
Boston, Mass.
Buffalo, N. Y.
Chicago, Ill.
Denver, Colo.
Duluth, Minn.
Huntington, W. Va.
Kansas City, Mo.
New York, N. Y.
Pittsburgh, Pa.
Portland, Ore.
St. Louis, Mo.
San Francisco, Calif.
Scranton, Pa.
Seattle, Wash.
Spokane, Wash.
Springfield, Ill.

Du Pont Products Exhibit
Atlantic City, N. J.

NON-HEADACHE DU PONT NON-FREEZING
DUMORITE

Gar Wood Says:
"That 90% of truck makers advise Wood-Detroit equipment attests its mechanical superiority; that 90% of users specify Wood-Detroit, proves its service."
Gar Wood

Built by "Gar" Wood

The dominance of Wood-Detroit Hydraulic Hoists and Steel Bodies in the dump truck field is so thorough that they not only exceed any other make, but all others combined.

Only an unequalled service record can account for this.

WOOD DETROIT

Hydraulic Hoists and Steel Bodies

If you are interested in dependability in your truck equipment; in speed; in labor saving; and in economy in handling bulk loads; if you demand full efficiency, specify Wood-Detroit.

We will gladly advise you as to the best size and style of Wood-Detroit equipment for your work and chassis.

Wood Hydraulic Hoist & Body Company

7924 Riopelle Street Detroit, Mich.

Sales and Service in All Principal Cities

ATLAS EXPLOSIVES
USED ON BIG JOBS EVERYWHERE

If Atlas chemists think it worth while to make "A Proper Explosive for Every Blasting Requirement," then it is good business for any one using explosives to make sure he is employing the ONE grade that is best suited to the work. To help you in selecting the RIGHT grade for your requirements is a feature of Atlas coöperation that goes with the use of Atlas Explosives. Write us today about this service.

ATLAS POWDER COMPANY
WILMINGTON, DEL.

Branch Offices:—Allentown, Pa.; Birmingham, Ala.; Boston; Chicago; Houghton, Mich.; Joplin, Mo.; Kansas City; Knoxville; McAlester, Okla.; Mexico City, Mexico; New Orleans; New York; Philadelphia; Pittsburg, Kans.; Pittsburgh, Pa.; Pottsville, Pa.; St. Louis; Wilkes-Barre.

The Maximum Measure of Strength and Capacity

Doing decidedly more than you expect is the performance of every Russell Machine—a most acceptable service.

They are designed and built to deliver the "extraordinary". They have extra strength built into every part and every piece of Russell Machinery is the product of long experience and studied foresight in road building requirements.

And remember this—when you buy Russell Road Equipment you are fully protected by an absolute guarantee covering service and capacity.

Everything needed for road construction, road maintenance and road repairing—

7 SIZES ROAD MACHINES—
2 SIZES ELEVATING GRADERS—
MAINTENANCE PATROL MACHINES FOR BOTH MOTOR AND HORSE POWER, SCARIFIERS, ROAD DRAGS, DRAG AND WHEEL SCRAPERS, DRAG LINES, GRAVEL SCREENING AND LOADING EQUIPMENT, CULVERTS, STEEL BEAM BRIDGES, Etc.

Our 64 page catalog of special interest to all road builders—sent free and postpaid.

RUSSELL GRADER MFG. CO.
FACTORY AND GENERAL OFFICES
MINNEAPOLIS, MINN.

Affiliated Plants—Cicero, Ill., North Kansas City, Mo., Memphis, Tenn., Dallas, Tex.

Representatives in all principal cities.

Build a Road That Resists Bombardment

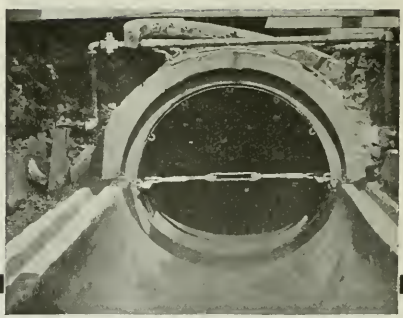
When the mighty guns on the Western front hurled broadsides of ponderous steel projectiles, the turrets and forts, regarded as impregnable, crumpled like cardboard. The result was a resort to earth trenches and embankments. Why? Because the only resistance possible was that of absorbing the shock instead of defying it. The same principle dictates shock absorbers and pneumatic tires for automobiles and trucks to protect the vehicle and its load. Our streets and roads must withstand the bombardment of more than four million truck wheels. The shock absorber in this case is the asphalt wearing course whatever the base. Asphalt—resilient, dustless, noiseless, waterproof, wearproof—the pavement of Broadway, Fifth Avenue, Michigan Boulevard, Broad Street, and Pennsylvania Avenue, is the last word in modern pavement design and is no more costly than a rigid, unprotected pavement.

Write for Brochures, Circulars and Specifications

The Asphalt Association

25 West Forty-third Street
NEW YORK CITY

Albany, N. Y. Atlanta, Ga. Chicago, Ill.
Newark, N. J. Raleigh, N. C.



Blaw Sewer Forms
Any Size-Any Shape

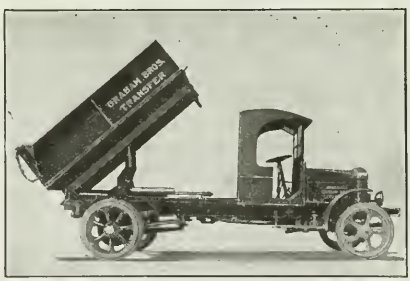
Consider the cost of lumber; the expensive expert labor required to build and knock down the forms and the large pile of almost useless lumber on your hands when the job is finished—and compare the appearances of a wood form and a steel form built sewer.

Blaw Sewer Forms are labor savers, time savers and money savers—they will build real sewers.

Blaw Sewer Forms of standard sizes and shapes are carried in stock—and leased to you. Sewers of especially large size or odd design require special forms, which we will design and build to suit your needs.

Submit your proposition to us for an estimate—write us.

BLAW-KNOX COMPANY
PITTSBURGH, PA. 611 Farmers Bank Bldg
NEW YORK-BOSTON-CHICAGO DETROIT-SAN FRANCISCO



Type DS-2 Standard Body, with Under-Body Hoist Specially Designed for Heavy Road Work

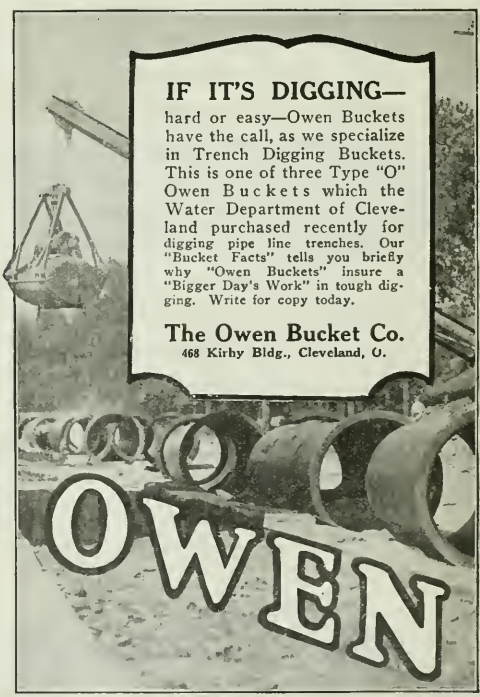
Greater Dumping Angle Than Any Other

Quick, clean dumping depends largely upon the dumping angle. Standard DS-2 Type bodies, equipped with under-body hoists, give a greater dumping angle than any other equipment.

Extra reinforced. Designed for road or building contractors' work. Body capacities up to six yards, ready for shipment. Write today for full description and new low prices.

STANDARD STEEL WORKS
North Kansas City, Mo.
All Repair Parts Carried in Stock at Kansas City

STANDARD DUMP BODIES AND HOISTS


IF IT'S DIGGING—
hard or easy—Owen Buckets have the call, as we specialize in Trench Digging Buckets. This is one of three Type "O" Owen Buckets which the Water Department of Cleveland purchased recently for digging pipe line trenches. Our "Bucket Facts" tells you briefly why "Owen Buckets" insure a "Bigger Day's Work" in tough digging. Write for copy today.
The Owen Bucket Co.
468 Kirby Bldg., Cleveland, O.
OWEN

NEWPORT CULVERTS

THE well-known strength of corrugated metal insures the purchaser of Newport Culverts that he is getting the maximum strength for supporting the overburden and traffic load. Made in full-round and half-round shapes to fit every condition. The moderate first cost is the only cost. They last a life-time. Full descriptive literature sent free on request.

100% QUALITY

NEWPORT CULVERT CO., *Incorporated*
542 W. 10th Street Newport, Kentucky

for STRENGTH

COLD PATCH

(1)
Repairing Bituminous Concrete

(2)
Same, two months later, showing repairs after being consolidated by travel

HEADLEY No. 1
AN ASPHALTUM EMULSION

For repairs and resurfacing.

No expensive heating plant required.

Can be used in wet or dry weather.

No time lost account wet materials.

Write for descriptive booklets.

ASPHALT AND ROAD OIL

HEADLEY GOOD ROADS CO. FRANKLIN TRUST BUILDING PHILADELPHIA, PA.

H&B PAVING BRICK TESTING MACHINE

Illustration shows N. P. B. M. Standard Rattler for testing of paving brick.

COMBINES ALL THE LATEST IMPROVEMENTS
and requirements of construction

Thoroughly tested and tried out for a period of one year under the direction of the technical committee of the National Paving Brick Manufacturers' Association.

Write for descriptive circular and prices.

HETHERINGTON & BERNER
INDIANAPOLIS, INDIANA

LOAD A FIVE-TON TRUCK FOR TWENTY-FIVE CENTS

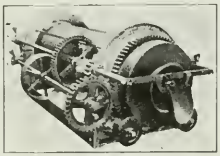
By Using a
RELIANCE PORTABLE CAR UNLOADER
and One Man

CAPACITY 25 TO 35 TONS AN HOUR

BEARS THE USUAL GENEROUS RELIANCE GUARANTEE
PRICES QUOTED WILLINGLY DELIVERIES MADE PROMPTLY

UNIVERSAL ROAD MACHINERY CO.

KINGSTON, N. Y.
RELIANCE ROAD BUILDING-LABOR SAVING EQUIPMENT



Washes
Gravel, Sand
Crushed Rock

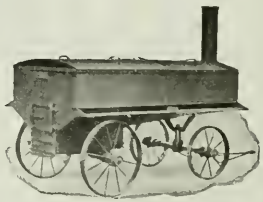
Stocker Improved Concrete Material Washer

Rakes and scoops the material against a constant flow of water, which frees it from dirt, clay and other impurities. Easily moved from one job to another —it is portable. All parts are interchangeable. Washes ten or more tons per hour. Write for further information.

P. M. WIEBE & SON - Highland, Illinois

Tar and Asphalt Heaters

Steel Stacks
Sand Dryers
Tool Heaters
Boiler Breechings
Welded or Riveted Tanks



THE JOS. HONHORST CO.
1016 West Sixth Street Cincinnati, Ohio

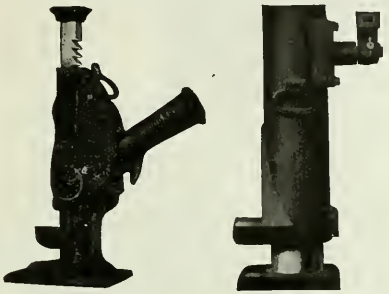
ASPHALT PLANTS ALL TYPES

The J. D. Farasey Mfg. Co.
Cleveland, Ohio

Duff Trench Braces

Why there are over 1,000,000 in use

DUFF JACKS
Two Popular Duff Jacks



Ratchet Jack Ball-Bearing Screw Jack

YOU know the cost of cave-ins. You know the danger to human lives. You know the cost and high loss of lumber struts and braces.

Duff extensible trench braces eliminate danger of cave-ins and accidents. They brace the trench securely. As they are quickly set and removed, they save labor.

Owing to the ball and socket joint, Duff braces securely grip the sheeting on each side of the trench, and cannot be accidentally dislodged. Neither vibration of machinery, nor careless acts of laborers can knock them down. That's a few of the reasons why contractors everywhere are making Duff trench braces as part of their regular and permanent excavating equipment.

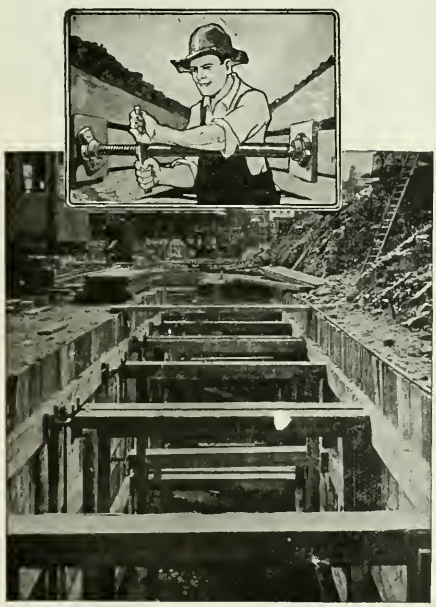
Send for Catalog of Duff Trench Braces and Lifting Jacks for all purposes.

The Duff Manufacturing Company

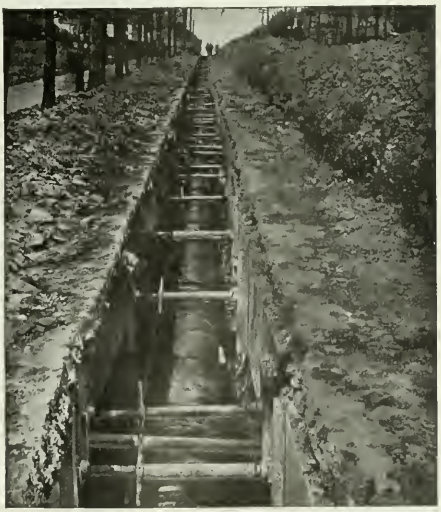
Established 1883 **.PITTSBURGH, PA.**

BRANCH OFFICES

50 Church Street, New York, N. Y. — Peoples Gas Building, Chicago, Ill. — Candler Building, Atlanta, Ga.
Railway Exchange Bldg., St. Louis, Mo. — Monadnock Bldg., San Francisco, Cal.



Duff Combination Screw and Timber Braces in foundation work, Bush Terminal Building, Strand, London, England.



A characteristic example of efficient, economical, and safe bracing in street excavation work. An effective arrangement of **Duff All-Iron Extensible Trench Braces** affording plenty of working space.

DURABILITY

Concrete Pipe supplied to the City of Kenosha, Wisconsin. Note pipe placed along line of trench and ease in excavating and backfilling.

STRENGTH—SPEED SATISFACTION

The unusual strength and ability to withstand exceptional loads has been a source of much satisfaction to many of the leading City Engineers.

The contractor knows that he can install Independent Concrete Pipe at a distinct saving in equipment, time and money. He knows that with the minimum of effort he can put in a perfect job at a good profit—a job that will satisfy the engineer in every respect.

Upon request we will be glad to submit data covering Independent Concrete Pipe from the viewpoints of the Municipality, the Contractor, and all others interested.

Ask for special booklet

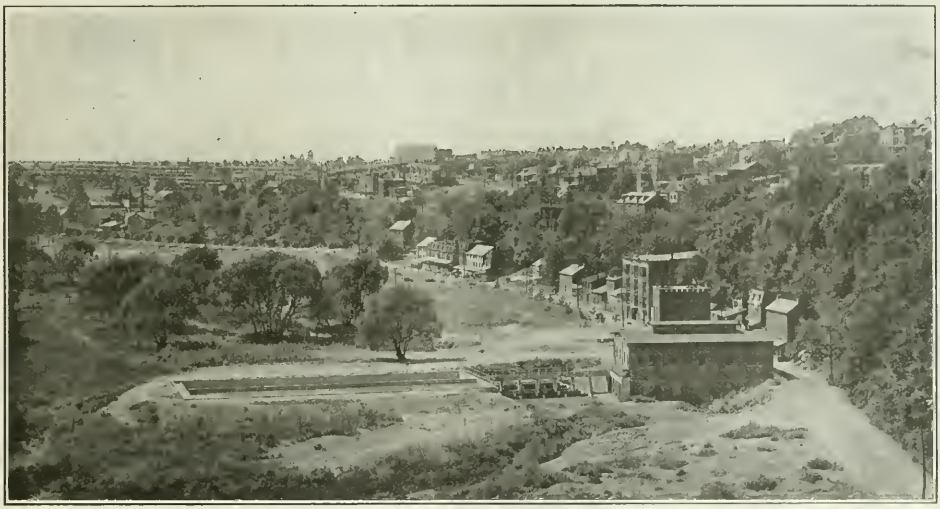
Independent Concrete Pipe Company

Indianapolis, Ind.

CONCRETE PIPE FOR PERMANENCE

Why should there be a Sewage Disposal "Problem"?

Direct Oxidation plants dispose of sewage without nuisance 365 days a year. Their installation and operation are no more a "Problem" than the building and operation of a lighting plant or a water pumping station.



Municipal Direct Oxidation Plant at Allentown, Pa. (Pop. 85,000)

Direct Oxidation plants may be located at the most economical point, without regard to isolation, as they produce neither odors nor flies.

DIRECT OXIDATION DISPOSAL CORPORATION

LAND TITLE BUILDING

PHILADELPHIA

VITRIFIED SEWER PIPE

from 8 Ohio Plants

Prompt Shipments

The Ohio Vitrified Pipe Co. Uhrichsville, Ohio

LOWEST HOTEL RATES IN NEW YORK
ACCOMMODATIONS BETTER THAN RATES INDICATE

BROADWAY CENTRAL HOTEL

Midway Between Battery and Central Park, Broadway at 3rd Street, New York City; Heart of Wholesale District; Capacity, 1,000 Guests.

Rates:
250 Cheerful Rooms, Free Use of Tub or Shower Bath $1.00
100 Cheerful Rooms, Free Use of Tub or Shower Bath $1.50
150 Cheerful Rooms, Private Bath.....$2.00 up

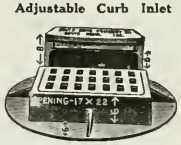
Two and Three Room Suites in Proportion

JAY G. WILBRAHAM, President

South Bend Foundry Co.

SOUTH BEND, INDIANA

Adjustable Curb Inlet



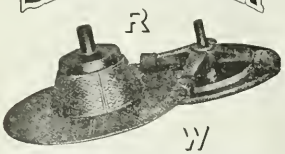
All Kinds of

Gray Iron Castings
Patent Chilled
Manhole Covers

WRITE FOR CATALOG AND PRICES

Made in 250, 300, 350 and 400, 470, 490 lbs. Weights

SANITATION



PROCESS

TRADE MARK
Reg. U. S. Pat. Office

HYDRAULIC and SANITARY EQUIPMENT

FOR MUNICIPAL WATERWORKS, SEWAGE SYSTEMS, IRRIGATION PROJECTS and DRYDOCKS

Sanitation-Geiger Gates, Valves and Control Apparatus, D'Olier Automatic Pumping Machinery and Ejectors, Sanitation-Geiger Water Screens, Larner-Johnson Valves

THE SANITATION CORPORATION

Engineers and Manufacturers

165 BROADWAY NEW YORK CITY

We ship Promptly

Try us on any quantity of

VITRIFIED SEWER PIPE

12 Plants
110 Cars Per Day

"Watch Our Speed"

The Robinson Clay Product Co.

Akron, Ohio

DEWATERING ACTIVATED SLUDGE HAS BEEN SOLVED

FOR

CHICAGO SANITARY DISTRICT

BY THE

"SIMPLEX" AUTOMATIC SLUDGE PRESSING EQUIPMENT

NO HEATING OF SLUDGE REQUIRED

WRITE FOR BULLETIN
ALSO FOR
AUOTOMATIC
SEWAGE EJECTORS

SIMPLEX EJECTOR CO.
1050 RANDOLPH STREET
CHICAGO, ILL.

WESTON PIPE GASKETS AND FORMS

No Breaks—No Lagging

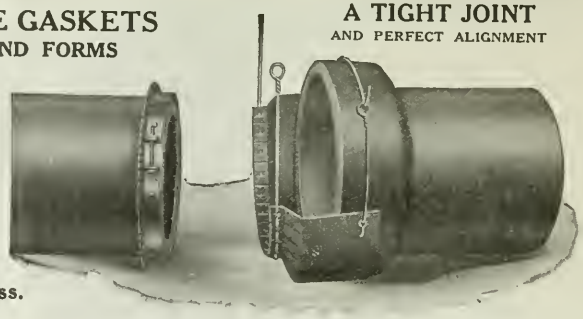
No Roots—No Skilled Labor

Facilitates the laying of sewers. Make water-proof joints. Free from every defect known to pipe laying. Permits partial back-filling of the trench before the joints are made, thus promoting proper alignment of the pipe and preventing the breakage of the joints during back-fill. Can be laid in trenches containing water and water running through the pipes.

Write for circular giving the full story.

L. A. WESTON, Adams, Mass.

A TIGHT JOINT
AND PERFECT ALIGNMENT



Loper Fire Alarm Company
STONINGTON, CONN.
Manufacturers of COMPRESSED AIR FIRE WHISTLES, WHISTLE BLOWERS, BELL STRIKERS, BOXES, GONGS, Etc., Etc.
Estimates Cheerfully Given

"STEWART SEWER CLEANING MACHINE"
"Used in Nearly Every State in the Union"

SEWER RODS

We pay freight and ship for trial. Who else will do it?
W. H. STEWART
1614 Locust Street, St. Louis, Mo.
133 George Street, Boston, Mass.

CUMMER ASPHALT PLANTS

Portable Plants (3 Units) four sizes; 750, 1250, 1800 and 2000 sq. yds. 2 inches top daily.

One-car steam melting 2000 square yards. 2 inches top daily.

THE F. D. CUMMER & SON COMPANY, CLEVELAND, OHIO

VULCAN INCINERATORS

The McCanse System
for Municipalities

ODORLESS AND SMOKELESS

The Most Economical

VULCAN INCINERATOR CO.
SECURITY BUILDING ST. LOUIS

SEWER AND HIGHWAY CASTINGS

The largest manufacturer of sewer and highway castings in the United States.

Send us your inquiries for manhole heads, inlet basins, etc., singly or by hundreds.

FLOCKHART FOUNDRY CO.
83 POLK STREET NEWARK, N. J.

Ridgewood, New York City
100 Ton Plant

DECARIE INCINERATORS

for Municipalities and Institutions

We are one of the oldest concerns in the United States engaged in the erection of incinerators for the final disposal of municipal refuse.

Our plants are of a distinctive type, and of scientific design passed upon years of experience. We have over 50 municipal installations in the United States and Canada. Among these are 15 repeat orders. Write us the conditions in your city and our engineers will furnish you with preliminary plans and proposals for the proper size of plant for your requirements.

STACY-BATES COMPANY
Selling Agents: McKnight Bldg., Minneapolis

Passaic, New Jersey
85 Ton Plant

JOINTITE

A
SEWER PIPE
JOINT
COMPOUND

No caulking is necessary with JOINTITE. Alternate joints may be poured on the bank. Easily handled and placed. No skilled help required. Sets as soon as poured. Adheres to the pipe.

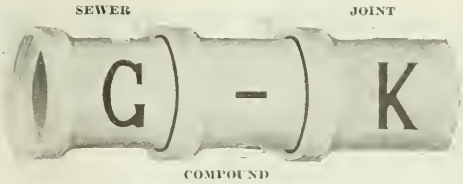
6 CATALOGS
on Airlock Apparatus for Sewers and Sewage Disposal

Catalog No. 15—Flush tank Siphons, Water Regulators
Catalog No. 16—Automatic Siphons for Domestic Septic Tanks
Catalog No. 21—Pneumatic Sewage Ejectors.
Catalog No. 12—Sewer Pipe Joint Compound.
Catalog No. 14—Automatic Siphons for Large Municipal Disposal Plants, etc.
Catalogue No. 7—Imhoff Tanks.

Catalogs mailed on request.

PACIFIC FLUSH-TANK CO.
149 Broadway New York

SEWER JOINT



G-K Compound Joints made in 8″ Vitrified Tile Pipe, were buried in marsh mud for one year, then excavated and tested by hydrostatic pressure: Result,

30 lbs. per sq. in.
15 min. duration.

Write Us for Particulars

G-K SALES AGENCY
Macungie, Penna.

D&D

SAFETY and NOISELESS
Manhole Cover
Does away with rattling or dishing

Our foundries and machine shops are equipped to handle work on a production scale. No order too large or small.

A large stock of stock patterns on hand and prompt deliveries assured. Special castings of soft gray iron from drawings or blueprints. We can also machine any castings to size.

Full particulars on request—send for catalogue.

WM. E. DEE COMPANY
30 N. La Salle Street Chicago, Ill.

Manhole, Catch Basin and Sewerage Castings of All Kinds. We Make Anything in Gray Iron
Write for Our Prices

NOW BUILDING
for
PHILADELPHIA
4-4 70-Ton Furnace
INCINERATORS
Total Capacity 280 Tons Daily

In accordance with the design of the present highly successful Toronto Incinerator.

The C. O. Bartlett & Snow Co.
Exclusive American Licensee
of the New Destructor Company's patents
Main Office and Works: Cleveland, O.

DIRECTORY OF CONSULTING ENGINEERS

ENGAGED IN MUNICIPAL AND PUBLIC WORK

ALVORD, BURDICK & HOWSON

John W. Alvord
Charles B. Burdick Louis R. Howson

Engineers

for

Water Works, Water Purification, Flood Relief, Sewerage, Sewage Disposal, Drainage, Appraisals, Power Generation.

Chicago Hartford Bldg.

THE AMERICAN APPRAISAL CO.

Milwaukee New York

Authoritative Reports and Valuations covering Public Utility, Municipal, Mineral, Industrial, Commercial and Residence properties.

BLACK & VEATCH

Consulting Engineers

Inter-State Bldg., Kansas City, Mo.

Sewerage, Sewage Disposal, Water Supply, Water Purification, Electric Lighting, Power Plants, Valuations, Special Investigations, Reports.

E. B. Black N. T. Veatch, Jr.

BROSSMAN, CHAS.

Consulting Engineer

Merchants' Bank Building
Indianapolis, Ind.

Water Supply. Sewerage and Disposal. Lighting Plants—Supervision of Construction and Operation. Appraisals—Expert Testimony.

BURNS & McDONNELL

Consulting Engineers

Appraisals, Expert Testimony, Sewerage, Rate Investigations, Water Works, Lighting.

Clinton S. Burns R. E. McDonnell

Kansas City, Inter-State Bldg.

CAIRD, JAMES M.

Assoc. Am. Soc. C. E.

Chemist and Bacteriologist

Office and Laboratory:
92 Fourth Street, Troy, N. Y.

Water Analysis and Tests of Filter Plants

DAVIS, B. H.

Consulting Engineer

Monumental Reinforced Concrete Bridges of All Types for Parks, Cities, Counties, States and Railroads. Consultations, Estimates, Plans, Specifications and Supervision.

Whitehall Building, New York

DOW & SMITH

Chemical Engineers

Consulting Paving Engineers
A. W. Dow, Ph.B. F. P. Smith, Ph.B.
Mem. Am. Inst. Ch. Engrs.
Mem. Am. Soc. Civ. Engrs.

Asphalt, Bitumens, Paving, Hydraulic Cement, Engineering Materials.

131-3 East 23d St., New York

New York City 116 W. 39th St.

A. E. HANSEN

Hydraulic and Sanitary Engineer

Design and Supervision of Construction

Sewerage	Water Works
Sewage Disposal	Water Purification
Drainage	Water Works Valuation
Garbage Disposal	Water Analysis

HAZEN & WHIPPLE

Hydraulic and Sanitary Engineers, Water Supply, Sewerage, Drainage, Valuations, Plans, Supervisions of Construction and Operation.

ALLEN HAZEN G. C. WHIPPLE
C. M. EVERETT L. N. BABBITT
MALCOM PIRNIE

30 East 42d St., New York City

NICHOLAS S. HILL, JR.

Consulting Engineer

Water Supply Sewage Disposal
Hydraulic Developments
Reports, Investigation, Valuations, Rates, Design, Construction, Operation, Management, Chemical and Biological Laboratories

112 E. 19th Street
New York City

MACLACHLAN REDUCTION PROCESS CO., Inc.

Specialists in the Dewatering and Disposal of Sewage Sludges, and all Deodorization Problems.

40 Rector St., New York City

CLARENCE D. POLLOCK

Mem. Am. Soc. C. E.
Consulting Engineer

Pavements, Highways, Drainage, Sewerage, Town Planning and General Municipal Problems.

Reports, Specifications, Supervision

Park Row Bldg., New York City

POTTER, ALEXANDER

50 Church St., New York City

Civil and Sanitary Engineer

Specialties: Water Supply, Sewerage and Pavements

BUYERS' CLASSIFIED DIRECTORY

of Names of Firms from Whom to Buy Material, Appliances and Machinery Needed by Public Works Departments and Contractors

CONTRACTORS' EQUIPMENT
(See Paving Machinery also)

Air Compressors
Ingersoll-Rand Co.
Schramm, Chris. D., & Son

Air Compressors, Portable
Ingersoll-Rand Co.

Aah Handling Mach.
Blaw Knox Co

Asphalt Paving Tools
Littleford Bros.

Backfillers
Pawling & Harnischfeger Co.

Blasting Powder
Atlas Powder
Du Pont de Nemours Co.

Bodies, Stake and Rack, Trucks and Trailers
Detroit Trailer Co.

Bodies, Dump (Steel) Trucks and Trailers
Detroit Trailer Co.

Bodies, Gravity Side Dump (Steel)
Detroit Trailer Co.

Bodies, Steel Platform with Wooden Stakes and Racks for Trucks and Trailers
Detroit Trailer Co.

Braces, Trench
The Duff Mfg. Co.

Bridges
Blaw-Knox Co.
Russell Grader Mfg. Co.
Truscon Steel Co.

Buckets, Automatic & Dumping
Blaw-Knox Co.
Littleford Bros.

Buckets, Clam Shell

Dragline, Orange Peel
Blaw-Knox Co.
L. P. Green
Russell Grader Mfg. Co.

Cars, Dumping and Industrial
Good Rds. Mchy. Co., Inc.
Equipment Co.

Carts, Concrete
Acme Road Mchy. Co.
Columbia Wagon & Body Co.
Etnyre & Co., E. D.

Castings
Burch Plow Works Co.
Republic Iron Works
South Bend Foundry Co.
U. S. Cast Iron Pipe & Foundry Co.

Chutes, Concrete
Littleford Bros.
U. S. Cast Iron Pipe & Foundry Co.

Concrete Block Machines
Republic Iron Works

Cranes, Locomotive
Ball Engine Co.
Erie Steam Shovel Co.
Koehring Co.
Orton & Steinbrenner
Pawling & Harnischfeger Co.

Cranes and Hoists
Pawling & Harnischfeger Co.

Crushers
Acme Road Mchy Co
Austin Western Road Machinery Co.
Good Rds Mchy Co., Inc
Universal Road Machinery Co.

Ditchers and Graders
Austin Western Road Machinery Co.
Russell Grader Mfg. Co.

Drills
Ingersoll-Rand Co.

Dump Bodies, Steel
Columbia Wagon & Body Co.
Heil Co., The
Littleford Bros.

Dump Bodies and Hand Hoists—Ford, Reo and other light trucks
Detroit Trailer Co.

Dump Wagons
Acme Road Mchy. Co.
Austin-West. Rd. Mach. Co.
Good Rds. Mchy Co., Inc.
Heil Co., The
Tiffin Wagon Co.

Engines
Avery Co.

Excavators
Ball Engine Co.
Blaw-Knox Co.
Erie Steam Shovel Co.
L. P. Green
Koehring Co.
Pawling & Harnischfeger Co.

Explosives
Atlas Powder Co.
E. I. du Pont de Nemours & Co.

Front Bumpers
Detroit Trailer Co.

Garbage Bodies, for Trucks and Trailers
Detroit Trailer Co.

Hammer Drills
Ingersoll-Rand Co.

Heaters, Asphalt & Tar
Connery & Co., Inc.
Farasey, J. D., Mfg. Co.
Honhorst, Jos., Co.
Littleford Bros.
Universal Road Machinery Co.

Hoists
Ingersoll-Rand Co.
Pawling & Harnischfeger Co.

Hoists, Hand, for Trucks and Trailers
Detroit Trailer Co.

Hoists, Hydraulic and Hand for Motor Trucks
Heil Co.

Hose
Goodyear Tire & Rubber Co.

Jacks, Lifting
The Duff Mfg. Co.

Kettles, Asphalt & Tar
Connery & Co., Inc.
Honhorst, Jos., Co.
Littleford Bros.
Universal Road Machinery Co.

Loading Machines
Conant Machine Co.

Metal Lath
Truscon Steel Co.

Motor Trucks
Avery Co.
Tiffin Wagon Co.

Pails
Rochester Can Co.

Paint
Ruberoid Co.
Servicised Products Co.

Paving Mixers
Koehring Co.

Pintle Hooks
Detroit Trailer Co.

Plows
Austin Western Road Machinery Co.
Avery Co.
Burch Plow Works Co.
Russell Grader Mfg. Co.
Wiard Plow Co.

Pneumatic Concrete Mixers and Placers

Pneumatic Tools
Ingersoll-Rand Co.

Pumps
Aurora Pump & Mfg. Co.
De Laval Steam Turbine Co.
Emerson Pump & Valve Co.
Ingersoll-Rand Co.
Schramm, Chris. D., & Son

Radiator Guards (Trucks)
Detroit Trailer Co.

Reinforcing Steel
Truscon Steel Co.

Rock Drills
Ingersoll-Rand Co.

Sharpeners
Ingersoll-Rand Co.

Shovels
Rochester Can Co.

Snow Removal Outfits
Austin Western Road Machinery Co.
Avery Co.
Holt Mfg. Co., Inc.
Russell Grader Mfg. Co.

Standard Steel Buildings
Littleford Bros.
Truscon Steel Co.

Steam Shovels
Ball Engine Co.
Erie Steam Shovel Co.

Tires
Goodyear Tire & Rubber Co.

Tool Heaters, Asphalt
Littleford Bros.

Tow Hooks (Trucks)
Detroit Trailer Co.

Track
Kuppel Industrial Car & Equipment Co.

Track-Laying Type of Tractors
Avery Company

Tractors
Avery Company
Holt Mfg. Co.

Trailers
Detroit Trailer Co.

Trailer Attachments
Detroit Trailer Co.

Trailer Hitches
Detroit Trailer Co.

Trailer Hooks
Detroit Trailer Co.

Trucks, Commercial
The Hug Co.
Tiffin Wagon Co.

Turn Tables
The Hug Co.
Western Structural Co.

FIRE DEPARTMENT EQUIPMENT

Combination Chemical and Hose Wagons
American-La France Fire Engine Co.

Fire Alarm System
Loper Fire Alarm Co.

Fire and Chemical Hose
Goodyear Tire & Rubber Co.

Pails
Rochester Can Co.

Pumping Engines Gasoline
American-La France Fire Eng. Co.
De Laval Steam Turbine Co.

Tires
Goodyear Tire & Rubber Co.

Triple Combination Motor
American-La France Fire Engine Co.

Underwriters' Pumps
De Laval Steam Turbine Co.

MISCELLANEOUS

Drawing Materials
F. Weber Co.

Engineering Supplies
F. Weber Co.

Tanks, Welded Steel
Heil Co.
Littleford Bros.

Transits and Levels
F. Weber Co.

PAVING AND ROAD MACHINERY

Air Compressors, Portable
Ingersoll-Rand Co.

Asphalt Distributors

Asphalt Plants
Cummer & Son Co.
Farasey, J. D., Mfg. Co.
Hetherington & Berner
Warren Bros. Co.

Car Unloaders
Acme Road Mchy. Co.
Burch Plow Works Co.
Good Rds. Mchy Co., Inc.
Universal Road Machinery Co.

Concrete Mixers
Good Rds. Mchy. Co., Inc.
Jaeger Mch. Co., The
Raher & Lang Mfg. Co.
Koehring Co.
Republic Iron Works

Concrete Continuous Proportioning Mixers
Raher & Lang Mfg. Co.

Culverts, Corrugated Metal
Austin Western Road Machinery Co.
Newport Culvert Co.

Gravel Screening Plants and Loaders
Austin Western Road Machinery Co.
L. P. Green
Russell Grader Mfg. Co.
Universal Road Machinery Co.

Heaters
Honhorst, Jos., Co.
Littleford Bros.

Oil Distributors and Sprayers
Acme Road Mach. Co.
Austin-West. Rd. Mach. Co.
Connery & Co., Inc.
Etnyre & Co., E. D.
Good Rds. Mchy. Co., Inc.
Littleford Bros.
The Kinney Mfg. Co.

Paving Breakers
Ingersoll-Rand Co.

Pumps—Oil and Asphalt
The Kinney Mfg. Co.
Etnyre & Co., E. D.

Road Graders
Acme Road Mchy. Co.
Austin-West. Rd. Mach. Co.
Ball Engine Co.
Erie Steam Shovel Co.
Good Rds. Mchy. Co., Inc.
Russell Grader Mfg. Co.
Universal Road Machinery Co.

Road Drags
Acme Road Mchy. Co.
Austin-West. Rd. Mach. Co.
Good Rds. Mchy. Co., Inc.
Russell Grader Mfg. Co.

Road Levellers
Austin Western Road Machinery Co.
Holt Mfg. Co., Inc.

Road Maintainers
Avery Co.
Austin-West. Rd. Mach. Co.
Littleford Bros.
Russell Grader Mfg. Co.

Road Pavement Testing Machines
Ingersoll-Rand Co.

Road Rollers
Acme Road Mchy. Co.
Avery Co.
Austin-West. Rd. Mach. Co.
Buffalo-Springfield Rol. Co.
Good Rds. Mchy. Co., Inc.

Road & Street Repair Plants
Littleford Bros.

Rock Crushers
Acme Road Mchy. Co.
Austin-West. Rd. Mach. Co.
Good Rds. Mchy. Co., Inc.
Universal Road Machinery Co.

Rock Drills
Ingersoll-Rand Co.

Motor Tandem Rollers
Austin-West. Rd. Mach. Co.

Scarifiers
Acme Road Mchy. Co.
Austin-West. Rd. Mach. Co.
Avery Co.
Buffalo-Springfield Rol. Co.
Good Rds. Mchy. Co., Inc.
The Hug Co.
Russell Grader Mfg. Co.
Universal Road Machinery Co.

Scrapers
Acme Road Mchy. Co.
Austin-West. Rd. Mach. Co.
L. P. Green
Good Rds. Mchy. Co., Inc.
Root Spring Scraper Co.
Russell Grader Mfg. Co.

Screens
Austin Western Road Machinery Co.
Acme Road Mach. Co.
Good Rds. Mchy. Co., Inc.
L. P. Green
Russell Grader Mfg. Co.
Universal Road Machinery Co.

Shovels
Rochester Can Co.

Spreaders
Acme Road Mach. Co.
Burch Plow Works Co.

Steel Forms
Heltzel Steel Form & Iron Works

Tar Kettles, Asphalt Heaters, etc.
Acme Road Mchy. Co.
Connery & Co., Inc.
Honhorst, Jos., Co.
The Kinney Mfg. Co.
Warren Bros. Co.

Tractors
Avery Co.
Holt Mfg. Co., Inc.

Turn Tables
The Hug Co.

Wagon Loaders
Conant Machine Co.

PAVING MATERIALS

Asphalt
Servicised Products Co
Standard Oil Co. (Ind.)
Standard Oil Co., (N. Y.)
Texas Co.

Binders
Barrett Co., The
Standard Oil Co. (Ind.)
Standard Oil Co., (N. Y.)
Texas Co.

Bituminous Pavements
Barrett Co., The
Texas Co.
Warren Bros. Co.

Contraction Joints
Truscon Steel Co.

Creosoted Wood Block
Republic Creo. Co.

Culverts, Corrugated Metal
Newport Culvert Co.

Curb Bars
Truscon Steel Co.

Expansion Joints
Barrett Co., The
Philip Carey Co.
Servicised Products Co.
Truscon Steel Co.

Fluxing Asphaltums
Standard Oil Co. (Ind.)

Oil (Roads)
Barrett Co., The
Headley Good Roads Co.
Standard Oil Co. (Ind.)
Standard Oil Co. (N. Y.)
Texas Co.

Paving Fillers
Standard Oil Co. (Ind.)

Reinforcing Mesh
Truscon Steel Co.

SEWERAGE

Culvert Molds, Concrete
Raher & Lang Mfg. Co.

Culverts
Burch Plow Works Co.
The Robinson Clay Prod.
Russell Grader Mfg. Co.

Culverts, Corrugated Metal
Newport Culvert Co.

See Alphabetical Index on last white page

INDEX TO ADVERTISEMENTS

A	Page
Acme Road Machinery Co.	44
Alvord, Burdick & Howson	60
American Appraisal Co.	60
American Cement Machine Co., Inc.	—
American La-France Fire Engine Co.	28
American Tel. & Tel. Co.	—
Asphalt Association	50
Atlas Powder Co.	49
Aurora Pump & Mfg. Co.	—
Austin Western Road Machinery Co.	2
Auto Engine Works	35
Avery Co.	—
B	
Badger Meter Mfg. Co.	37
Ball Engine Co.	16
Barrett Co., The	1
Bartlett & Snow Co., The,	59
Black & Veatch	60
Blaw-Knox Co.	50
Bourbon Copper & Brass Co.	40
Broadway Central Hotel	56
Brossman, Chas.	60
Buffalo Springfield Roller Co.	47
Burch Plow Works	—
Burns & McDonnell	60
C	
Caird, James M.	60
Carey, Philip, Co.	3
Clark, H. W., Co.	31
Coldwell-Wilcox Co.	40
Columbia Wagon & Body Co., Inc.	—
Connery & Co., Inc.	—
Cook, A. D.	40
Cummer & Son, F. D.	58
D	
Davis, B. H.	60
Dayton-Dowd Co.	40
Decarie Incinerator Co.	58
Dee, Wm. E., Co.	59
Detroit Trailer Co.	11
Direct Oxidation Disposal Corp.	55
Dow & Smith	60
Duff Mfg. Co., The	53
Du Pont de Nemours Co., E. I.	48
E	
East Jersey Pipe Co.	29
Eastern Clay Products Ass'n.	4, 5
Electro Bleaching Gas Co.	36
Emerson Pump & Valve Co.	34
Erie Steam Shovel Co.	16
Etnyre, E. D., & Co.	14
Evinrude Motor Co.	33
F	
Farasey, J. D., Mfg. Co.	52
Flockhart Foundry Co.	58
G	
Gamon Meter Co.	30
G. K. Sales Agency	59
Good Roads Machinery Co.	—
Goodyear Tire & Rubber Co.	41
Green, L. P., Co.	—
H	
Hansen, A. E.	60
Hazen & Whipple	60
Headley Good Roads Co.	51
Heil Company	46
Heltzel Steel Form & Iron Co.	43
Hetherington & Berner	10, 52
Hersey Mfg. Co.	63
Hill, Nicholas S., Jr.	60
Holt Mfg. Co.	13
Honhorst Co., The Jos.	52
Hug Co., The	—
I	
Independent Concrete Pipe Co.	54
Ingersoll-Rand Co.	—
J	
Jaeger Machine Co.	6
K	
Kinney Mfg. Co.	8
Koehring Co.	15
L	
Loper Fire Alarm Co.	58
M	
Maclachlan Reduction Process Co., Inc.	60
Marine Metal & Supply Co.	—
Michigan Valve & Fdy. Co.	32
Mueller Mfg. Co.	23
N	
Nat'l Cast Iron Pipe Co.	38
Nat'l Water Main Cleaning Co.	36
Newport Culvert Co.	51
New York Continental Jewel Filtration Co.	38
Nye Odorless Crematory Co.	42
O	
Ohio Municipal Equipment Co.	—
Ohio Vitrified Pipe Co.	56
Orton & Steinbrenner Co.	10
Owen Bucket Co.	50
P	
Pacific Flush-Tank Co.	59
Pawling & Harnischfeger Co.	—
Penn. Salt Mfg. Co.	30
Pittsburgh Meter Co.	27
Pollock, Clarence D.	60
Potter, Alexander	63
R	
Republic Iron Works	—
Robinson Clay Product Co.	57
Ruberoid Co.	—
Russell Grader Mfg. Co.	49
S	
Sanitation Corporation	56
Schramm, Inc.	37
Simplex Ejector Co.	57
Smith, A. P., Mfg. Co., The	35
South Bend Foundry Co.	56
Springfield Motor Roller Co.	17
Stacy-Bates Co.	58
Standard Inspection Co.	40
Standard Oil of Indiana	9
Standard Oil Co. (N. Y.)	12
Standard Steel Works	50
Sterling Eng. Co.	39
Stewart, W. H.	58
Stumpf Una-Flow Engine Co.	34
Sweet's Steel Co.	—
T	
Texas Co.	18, 64
The Martinique	—
Thomson Meter Co.	25
Tiffin Wagon Co.	46
Truscon Steel Co.	—
U	
Union Water Meter Co.	34
U. S. Cast Iron Pipe & Fdy. Co.	39
Universal Road Mach. Co.	52
V	
Vulcan Incinerator Co.	58
W	
Warren Bros. Co.	7
Weber, F., Co.	—
Weston, L. A.	58
Wiard Plow Co.	45
Wiebe, P. M.	52
Wood, R. D., & Co.	36
Wood Hydraulic Hoist & Body Co.	48
Wyckoff & Son Co., A.	40

BUYERS' CLASSIFIED DIRECTORY

(CONTINUED)

Drain Tile
Robinson Clay Prod. Co.

Flush Tank Siphons
Pacific Flush-Tank Co.

Inlet Basins
Flockhart Foundry Co.

Joint Compound (Bituminous)
Ruberoid Co.

Manhole Heads
Flockhart Foundry Co.

Molds, Sewer Pipe, Concrete
Raher & Lang Mfg. Co.

Pipe (Cast Iron)
Nat'l Cast Iron Pipe Co.
U. S. Cast Iron Pipe & Fdry. Co.
R. D. Wood & Co.

Pipe Cleaning Machines
W. H. Stewart

Pipe (Reinfr. Concrete)
Independent Con. Pipe Co

Pumps
Aurora Pump & Mfg. Co.
De Laval Steam Turbine Co.

Rods
W. H. Stewart

Segment Block Sewer
Robinson Clay Prod. Co.

Sewage Disposal Apparatus
Dirct Oxidation Disposal Corp.
Pacific Flush-Tank Co.

Sewage Disposal Plants
Direct Oxidation Disposal Corp.
Sanitation Corporation

Sewage Disinfection
Dirct Oxidation Disposal Corp.
Electro Bleaching Gas Co.

Sewage Ejectors
Pacific Flush-Tank Co.

Sewage Pumps
De Laval Steam Turbine Co.

Sewer Joint Compounds
G. K. Sales Agency
Pacific Flush-Tank Co.

Sewer Castings
Flockhart Foundry Co.

Vitrified Fire Clay Sewer Tiles
East Ohio Sewer Pipe Co.
Robinson Clay Prod. Co.

Vitrified Sewer Pipe
Eastern Clay Products Association
East Ohio Sewer Pipe Co.
Ohio Vitrified Pipe Co.
Robinson Clay Prod. Co.

STREET CLEANING AND REFUSE DISPOSAL

Ash Bodies
Heil Co.

Ash Cans
Rochester Can Co.

Carts
Acme Road Mchy. Co.
Columbia Wagon & Body Co
Tiffin Wagon Co.

Garbage Bodies, Steel
Columbia Wagon & Body Co.
Heil Co., The
Littleford Bros.

Incinerators
Decarie Incinerator Co.
Stacy-Bates Co.
Vulcan Incinerator Co.

Manholes—Catch Basins
Burch Plow Works Co.
Wm. E. Dee Co.
South Bend Foundry Co.

Shovels
Rochester Can Co.
Wyoming Shovel Works

Sprinkling Wagons and Flushers
Austin-West. Rd. Mach. Co.
Etnyre & Co., E. D.
Good Rds. Mchy. Co., Inc.
The Kinney Mfg. Co.
Tiffin Wagon Co.

Street Flushing Hose
Goodyear Tire & Rubber Co.

Street Scrapers
Rochester Can Co.

Street Sweepers
Austin-West. Rd. Mach. Co.
Ohio Municipal Equip. Co.
Springfield Motor Sweeper Co.
Universal Road Machinery Co.

STREET SIGNS

Ingram-Richardson Co.

WATER WORKS

Air Compressors
Ingersoll-Rand Co.

Air Lift
Ingersoll-Rand Co.

Brass Water Connection
Mueller, H., Mfg. Co.

Centrifugal Pumps
Aurora Pump & Mfg. Co.
De Laval Steam Turbine Co.

Chloride of Lime
Penn Salt Mfg. Co.

Chlorine Liquid
Electro Bleaching Gas. Co

Deep Well Drills
Ingersoll-Rand Co.

Deep Well Pumps
Aurora Pump & Mfg. Co.
Cook, A. D.
Ingersoll-Rand Co.

Disinfecting Chemicals
Electro Bleaching Gas Co.
Penn Salt Mfg. Co.

Filters
N. Y. Continental Jewel Filtration Co.

Filtration Plants

Filter Alum
Du Pont de Nemours Co.

Fire Hydrants
Clark Co., H. W.
R. D. Wood & Co.

Flap Valves
Coldwell-Wilcox Co.

Meters
Badger Meter Mfg. Co.
Clark Co., H. W.
Hersey Mfg. Co.
Pittsburgh Meter Co.
Thompson Meter Co.
Union Water Meter Co.

Meter Boxes
H. W. Clark Co.
Pittsburgh Meter Co.

Meter Testing Machines
H. W. Clark Co.
Mueller, H., Mfg. Co.
Pittsburgh Meter Co.

Pipe, Cast Iron
National Cast Iron Pipe Co.
U. S. Cast Iron Pipe & Fdy. Co.

Pipe, Steel
East Jersey Pipe Co.
Littleford Bros.

Pipe, Wood
A. Wyckoff & Son Co.

Pumps
Aurora Pump & Mfg. Co.
H. W. Clark Co.
Cook, A. D.
Dayton-Dowd Co.
De Laval Steam Turbine Co.

Pumping Engines
De Laval Steam Turbine Co.
Sterling Engine Co.

Screens for Wells
Cook, A. D.

Service Boxes
Mueller, H., Mfg. Co.

Shear Valves
Coldwell-Wilcox Co.

Sleeves and Valves
Mueller, H., Mfg. Co.
Smith, A. P., Mfg. Co.

Sluice Gates
Coldwell-Wilcox Co.

Sprinkling and Flushing Hydrants
Mueller, H., Mfg. Co.

Steel Stacks
Heil Co., The
Hoohorst, Jos., Co.
Littleford Bros.

Strainers
Cook, A. D.

Tanks
Etnyre & Co., E. D.
Farasey, J. D., Mfg. Co.
Heil Co., The
Honhorst, Jos., Co.
Littleford Bros.

Tanks, Towers, Standpipes
Connery & Co., Inc.
Farasey, J. D., Mfg. Co.
Littleford Bros.

Tapping Machines
Mueller, H., Mfg. Co.
Smith, A. P., Mfg. Co.

Tunnel Liner Plates
Truscon Steel Co.

Valves
Clark Co., H. W.
Mueller, H., Mfg. Co.

Vitrified Pipe
Eastern Clay Products Association

Water Main Cleaning
National Water Main Cleaning Co.

Water Purification
Electro Bleaching Gas Co
N. Y. Continental Jewel Filtration Co.

Water Sterilization
Electro Bleach Gas Co.

Water Strainers
Mueller, H., Mfg. Co.

Water Supply from Well Systems
Cook, A. D.
Heil Co., The

TD
1
P8
v.53
[redacted]
Engineering

PLEASE DO NOT REMOVE
CARDS OR SLIPS FROM THIS POCKET

UNIVERSITY OF TORONTO LIBRARY

[redacted] STORAGE

Public works